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BULLETIN

OF THE

TORREY BOTANICAL CLUB

NOVEMBER 1925

A revision of the species of Radula of the United States and Canada*

HEMPSTEAD CASTLE

(WITH ELEVEN FIGURES)

RADULA Dumortier, Comm. Bot. 112. 1822

Martinellius S. F. Gray, Nat. Arr. Brit. Pl. **1**: 690. 1821.[1]
Stephanina O. Kuntze, Rev. Gen. Pl. 839. 1891.

Plants green, frequently tinged with brown or yellow: in northern species stems one to several centimeters in length, in tropical species up to one foot in length, prostrate or pendulous and frequently forming depressed mats on rocks, bark, and in a few species on living leaves, more or less loosely and irregularly pinnately and bipinnately branched, in a few species sometimes dichotomous by subfloral innovations, the branches infrafoliar in origin: leaves alternate, more or less imbricate, conduplicate-bilobed; the lobes almost always entire, the ventral lobe smaller, often inflated near the keel, the free margin usually appressed to the dorsal lobe: underleaves entirely wanting: rhizoids usually present and always arising from the mammilliform swelling of the ventral lobe: leaf cells usually uniformly thin-walled, occasionally with marked trigones: species mostly dioicous, a few monoicous: the male inflorescence, in dioicous species, often amentiform, terminal on the stem or a main branch but often proliferating, more rarely intercalary; in monoicous species similar or situated directly below the female inflorescence; male bracts densely imbricate, in two to thirty-five pairs, subequally lobed, much inflated at the base; antheridia single, more rarely in two's or three's: female inflorescence

*Contribution from the Osborn Botanical Laboratory.

[1] Reasons for using the generic name *Radula* instead of *Martinellius* are presented by M. A. Howe (Mem. Torrey Club **7**: 157. 1899) and by A. W. Evans (Trans. Conn. Acad. **8**: 265. 1892).

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borne usually on the stem or a main branch, and in most species subtended by one or two subfloral innovations; female bracts a single pair, usually somewhat smaller than the stem leaves; the ventral lobe proportionately smaller and always without rhizoids; archegonia several: perianth in most cases strongly compressed dorsiventrally toward the free end, usually terete toward the base, usually not at all carinate or plicate, the mouth broad, more or less bilabiate, the truncate lips entire, or repand-crenate: calyptra narrowly obovoid or elongate pyriform, rather firm and subopaque, the walls composed of two to three layers of cells: capsule oval-cylindrical, two to four times as long as broad, four-valved to the base, the valves bistratose; radial walls of the outer layer of cells with moniliform or nodular thickenings, radial walls of the inner layer less heavily and more uniformly thickened, delicate transverse striae present on the inner tangential walls in some species: seta stout, usually not much exceeding the perianth at maturity: spores globose, minutely granulate-papillate or subechinate: elaters long and slender, obtuse, and usually bispiral: vegetative propagation by means of discoid gemmae or caducous leaves.

KEY TO SPECIES

a. Plants of tropical, temperate or northern distribution, growing on bark or rocks; monoicous or dioicous; discoid gemmae, when present, small.
  b. Plants not producing gemmae; with or without rhizoids.
    c. Leaves exhibiting no tendency to shed the dorsal lobe; plants dioicous.
      d. Dorsal lobe strongly falcate; pronounced trigones usually present in the leaf cells; plants usually tinged with brown. 1. *R. tenax*
      d. Dorsal lobe not at all or only very slightly falcate; trigones absent or minute; plants usually not tinged with brown.
        e. Leaves ascending; dorsal lobe spoon-shaped; male inflorescence a long, slender ament; rhizoids present, gemmae absent. 2. *R. Bolanderi*
        e. Leaves wide spreading; plants of plumose habit; rhizoids entirely lacking. 3. *R. polyclada*
    c. Leaves exhibiting a marked tendency to shed the dorsal lobe.
      d. Leaves strongly falcate; dioicous.
        e. Base of lobule fused to the stem almost its entire length by a straight line; dorsal lobe not extending beyond the stem; male inflorescence intercalary or, if apparently terminal, with a slight proliferation at the tip. 4. *R. Sullivantii*

e. Base of lobule free one-third to one-half its length, the free portion auriculate and arching over on the stem; dorsal lobe extending across the stem and usually beyond; male inflorescence amentiform, terminal on the stem or a branch but proliferating slightly at the tip; more rarely intercalary. 5. *R. australis*

d. Leaves only slightly falcate; heteroicous. Base of lobule free half its length, the free portion not auriculate; dorsal lobe extending across the stem but not beyond. 6. *R. obconica*

b. Plants producing gemmae; rhizoids present.

c. Lobule blunt pointed often with slightly prolonged blunt tip, free basal portion slightly auriculate, extending half-way across the stem—rarely more.

d. Perianth not split on one side; female flowers terminal with one or two subfloral innovations.

e. Plants paroicous; sexual structures almost invariably present even when gemmae are abundant. 7. *R. complanata*

e. Plants dioicous; sexual structures rare; especially when gemmae are abundant. 8. *R. caloosiensis*

d. Perianth split on one side half its length; female flowers usually pseudolateral by the extension of a single innovation; gemmae rare. 9. *R. Langloisii*

c. Lobule usually broadly rounded at the apex; free basal portion markedly auriculate and extending across and beyond the stem; plants always sterile and with abundant discoid gemmae. 10. *R. andicola*

a. Plants of tropical and subtropical regions, growing only on living leaves of trees, shrubs, and herbs; dioicous; vegetative reproduction by means of large, circular, discoid gemmae. 11. *R. flaccida*

1. RADULA TENAX Lindberg, Acta Soc. Sci. Fenn. **10:** 492. 1875

Radula pallens Sulliv. Musci Alleg. *261.* 1846. Not *R. pallens* (Sw.) Dum.

Plants dull green usually with a bronze cast: stems 1–6 cm. in length and 0.2 mm. in width, pinnately and in most cases bipinnately branched, the branches wide-spreading and arising at frequent intervals along the stem, separated by two to six leaves: stem leaves not overlapping on the older portions of the plant, subimbricate toward the growing tip, spreading from the stem at an angle of 80°, somewhat falcate, the keel straight or more

rarely slightly incurved or faintly arched; dorsal lobe 1.4 × 0.65 mm., ovate, somewhat convex, the margin entire, apex rounded, the base free two-thirds its length, auriculate, arching across the stem, the line of attachment oblique on the axis; ventral lobe 0.15 × 0.1 mm., quadrate, the apex somewhat obtusely angled, the base rounded, definitely auriculate, and extending from one-fourth to the entire distance across the stem; rhizoids infrequent, in most cases completely lacking: leaf cells with usually well defined trigones with straight or slightly bulging sides; cells of the leaf margin 18 × 15 μ; median cells 23 × 18 μ; basal cells 23 × 18 μ: leaves of the branches of the first order smaller, usually subimbricate, not at all falcate and obliquely spreading from the axis at an angle of 60°–70°; the keel never straight or incurved but always slightly arched; dorsal lobe 0.4 × 0.3 mm., ovate, the apex rounded; ventral lobe 0.23 × 0.15 mm., subquadrate, frequently with rhizoids: dioicous: male inflorescence intercalary on a branch, less frequently terminal, of two to nine pairs of bracts, the bracts closely imbricate, much inflated at the base, the keel strongly arched; the dorsal lobe 0.6 × 0.4 mm., usually erect, rounded at the tip and the base arching across and some distance beyond the axis; the ventral lobe 0.4 × 0.3 mm., bluntly angled at the tip, its base partially free, auriculate, and arching nearly across the axis: female inflorescence terminal on the stem or a leading branch, usually with a single innovation, more rarely innovating on both sides, one innovation not developing beyond a bud, the other continuing the growth of the stem and pushing the female flower into a lateral position; female bracts wide spreading, usually becoming widely separated and often freely exposing the archegonia; dorsal lobe 1 × 0.6 mm., narrowly ovate; ventral lobe 0.4 × 0.4 mm., subquadrate, the base rounded into a pronounced auricle; perianth unknown.

TYPE LOCALITY: ad truncos emortuos in Marylandia et Carolina Superiore.

HABITAT AND DISTRIBUTION: in depressed, dense mats on moist rocks, less frequently on trunks of trees, in mountainous and hilly regions; throughout New England and southward to North Carolina.

ILLUSTRATIONS: Lorenz, A., Bryologist **11**: *pl. 2.* 1908.

MAINE: Greenville, 1911, *Evans* (Rhodora **14**: 17. 1912).—NEW HAMPSHIRE: Shelburne, 1883, *Farlow;* near Coösauk Falls, Mt. Madison, *Evans,* Crystal Cascade, White Mts., *Underwood & Cook,* Hep. Amer. *52;* Franconia Notch, *Evans et al.;* the Pool, Franconia, *Farlow;* Waterville, *A. Lorenz 75, Evans.*—VERMONT: Granville Notch, 1916, *Weatherby* (Lorenz, A., Bull. Vt.

Bot. & Bird Club **3**: 8. 1917); Birch Hill, Brandon, *Dutton 1375, 1377*.—MASSACHUSETTS: Chebocco Lake, Manchester, 1903, *Farlow;* Sheffield, *A. Lorenz*.—CONNECTICUT: Beacon Falls, 1890, *Evans;* Branford, Salisbury and Redding, *Evans;* Salisbury, *A. Lorenz 269, Nichols* (distributed in Haynes, Amer. Hep. *89*); Redding, *C. C. Haynes 896*. Most of these localities are recorded by Evans and Nichols, Bull. Conn. Geol. & Nat.

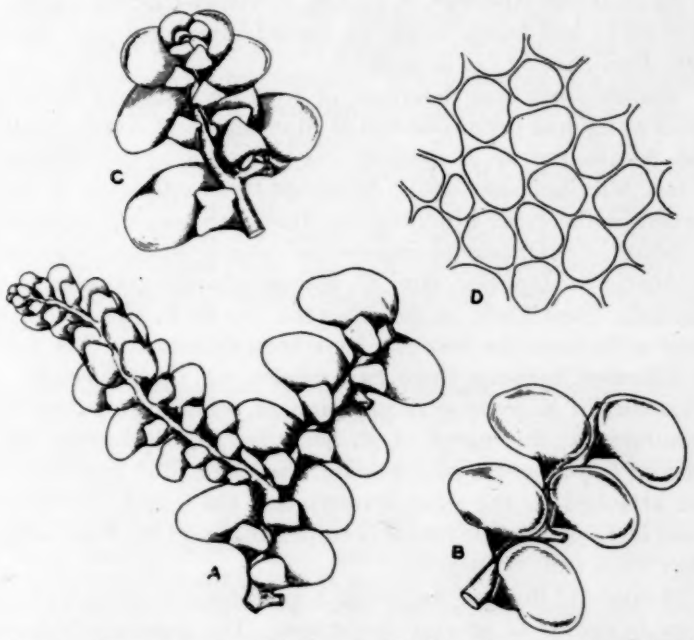

FIG. 1. RADULA TENAX Lindb. A. Portion of a male plant showing the intercalary male inflorescence, ventral view, × 18. B. Portion of a sterile plant, dorsal view, × 18. C. Portion of a female plant showing the pseudo-lateral female flower, ventral view, × 18. D. Leaf cells showing thickenings at the cell angles, × 450.

Hist. Surv. **11**: 70. 1908.—NEW YORK: Onteora Mt., near Tannersville, 1891, *A. M. Vail 5;* Little Moose Lake, Herkimer Co., *C. C. Haynes 1409*.—MARYLAND: without definite locality, *Sullivant*, distributed (as *R. pallens*) in Musci Alleg. *261*.—VIRGINIA: Nick's Creek, 1892, *E. G. Britton 44;* White Top Mt., *E. G. Britton 6, 102;* same locality, *Small* (distributed in Blue Ridge Hepatics, S. W. Virginia *61*). These localities are re-

corded by Small & Vail, Mem. Torrey Club **4**: 193. 1893.— WEST VIRGINIA: Tibbs Run, 1892, *Millspaugh* (Bull. W. Va. Agr. Expt. Station **24**: 495. 1892.); Fairview, *E. M. Fling.*— NORTH CAROLINA: without definite locality, *Sullivant*, distributed (as *R. pallens*) in Musci Alleg. *261*; near Montreat, Buncombe Co., *Standley & Bollman 10160* (H.). This species was also reported as collected by Atkinson in 1901 at two stations in the state (see Andrews, A. LeRoy, Bryologist **17**: 59. 1914).— "On rocks and fallen trunks in mountainous regions," *Austin*, Hep. Bor. Am. *87* (as *R. pallens*).[2]

Radula tenax was described in 1875 by Lindberg from material which had been collected in Maryland and North Carolina and distributed as *R. pallens* (Sw.) Dumortier in Sullivant's Musci Alleghanienses 261. Although this material is to be regarded as the type, Lindberg also based his species on material collected in mountainous regions (no definite station) and issued by Austin in Hep. Bor. Am. *87*, and on material collected in the Catskills, New York, in August 1868, by P. T. Cleve. Of the three collections the first two have been examined. The points of difference between these two species are the following: the branching in *R. tenax* is simply pinnate, while in *R. pallens* it is dichotomous; the leaves of *R. tenax* are elliptical-ovate, while those of *R. pallens* are round-ovate; the lobule of *R. tenax* is ovate and attached to the stem scarcely half the length of the base, while in *R. pallens* the lobule is trapezoidal and the base is fused more than half its length.

A study of this species reveals a considerable amount of variation in regard to several characters. The most marked variation probably is in connection with the trigones. Austin's material and also the majority of the specimens collected in the South show rather pronounced thickenings in the angles of the leaf cells. On the other hand much of the northern material shows an absence of trigones, although cell thickenings are conspicuous in some material as, for example, in the specimen from Sheffield, Mass. Although trigones are usually present in the southern material, they are not absolutely constant and may also

[2] In this and the other lists of specimens examined "H." signifies the herbarium of Miss Caroline C. Haynes, and "N. Y." the herbarium of the New York Botanical Garden. The remaining specimens are in the herbarium of Yale University.

vary in degree. Material collected by E. M. Fling at Fairview, West Virginia, possesses leaf cells with extremely thin walls and no trigones. Very obviously the degree to which the cell angles may be thickened is so variable that it can possess no real specific value. In addition to this, in many cases, there is a marked difference in the general appearance between plants collected in the North and those from the southern limit of the range. Frequently in northern material the plants are less robust and have the appearance of the branches of the first order of the southern forms. This may possibly be interpreted as a juvenile condition beyond which many of the plants of more northern distribution are not able to pass.

R. tenax possesses no definite structures for vegetative propagation nor does this species shed its leaves. However, old portions of plants, which are almost in a state of disintegration, may produce abundantly at any location on the surface of the leaves small, tuberous outgrowths, which then give rise to leafy shoots.

2. RADULA BOLANDERI Gottsche; Stephani, Hedwigia **23:** 145. 1884

Radula spicata Aust. Bull. Torrey Club **6:** 19. 1875. Not *R. spicata* Mitt., 1862.

Radula arctica Steph. Bot. Jahrb. **8:** 98. 1886.

Plants usually dark green, dull, often becoming yellowish green with age: stems 1–2 cm. in length and 0.09 mm. in width, somewhat regularly pinnately and bipinnately branched, the branches 1–5 mm. in length and 0.06 mm. in width, alternate, separated usually by two leaves of the stem and spreading obliquely at an angle of 70°–80°, frequently simple but more often with a few short branches of the secondary order: stem leaves scarcely imbricate, spreading from the stem obliquely at an angle of 60°–70°, the keel straight or more often slightly arched; the dorsal lobe 0.8 × 0.65 mm., ovate, decidedly convex, the base free about one-half its length, the free portion arching usually almost across the stem, the fused base attached to the stem by a straight line, the apex broadly rounded; the ventral lobe 0.45 × 0.35 mm., subquadrate, the base free about half its length, the free portion subauriculate, arching part way across the stem, the line of attachment oblique, the apex blunt and almost forming a right angle; rhizoids usually present on a somewhat inflated cushion at the base of the lobule; leaf cells comparatively thin-walled, usually with small thickenings at the angles; cells of the

margin of the dorsal lobe 15 × 11 μ, cells of the median portion 18 × 14 μ, cells of the base 18 × 15 μ; leaves of the branches of the first order slightly imbricate, obliquely spreading as those of the stem; the keel somewhat more arched; the dorsal lobe 0.35 × 0.3 mm., ovate, convex; the ventral lobe as in the stem leaves, 0.25 × 0.2 mm., usually with an inflated base bearing rhizoids; leaves of the axes of the second order subequally bilobed, 0.15 × 0.13 mm.; the keel much arched; rhizoids absent; dioicous; the male inflorescence a long, slender, compact ament of two to thirty pairs of bracts, usually terminal on the stem or a branch of the first order, occasionally proliferating at the tip; the bracts much inflated at the base, subequally lobed, 0.5 × 0.35 mm., the lobes rounded at the tip; rhizoids absent: female inflorescence terminal on the stem or a leading branch, usually innovating on one or both sides, the innovations in most cases not fertile and usually not longer than other branches of the first order, less frequently bearing female flowers and assuming stem-like growth; female bracts subequally bilobed, about the size of the stem leaves, the keel straight or slightly inwardly curved; the dorsal lobe 0.85 × 0.45 mm., broadly rounded at the tip; the ventral lobe 0.7 × 0.45 mm., rounded at the tip; perianth 1–2 mm. in length, tapering from a narrow base abruptly to a wide, shallowly two-lipped, faintly and coarsely undulate mouth, strongly flattened toward the free end: capsule oval-cylindrical; the outer layer of cells with strong, horizontal bands of thickening on all the vertical, radial walls, the thickenings often extending slightly over the outer tangential wall and separated or more rarely confluent; the inner layer of large, more irregular cells, thickened more or less uniformly on most of the radial walls, transverse bands of thickening on the tangential walls absent.

TYPE LOCALITY: California. Mendocino City, leg. *Bolander.*

HABITAT AND DISTRIBUTION: on moist rocks or on the bark of trees; frequent along the Pacific Coast of North America from California to Alaska.

ILLUSTRATIONS: Stephani, Bot. Jahrb. **8:** *pl. 3. f. 11.* 1886; Pearson, W. H., Can. Hep. *pl. 4.* 1890.

ALASKA: Port Etches, 1892, *Underwood 448* (H.); Ratz Harbor, *Frye 297, 312* (Evans, A.W., Bull. Torrey Club **41:** 606. 1914).—BRITISH COLUMBIA: Observatory Inlet, *Douglas* (N. Y.) no date given; Vancouver, *Pringle 536* (N. Y.); Victoria, *Macoun 17, 40, 107;* Ucluelet, *Macoun 22, 41, 43, 81, 113;* Esquimalt, *Macoun 30;* Sidney, *Macoun 41* (H.); Vancouver I., *Macoun 13* (N. Y.), *17* (N. Y.); Comox, *Macoun 82* (N. Y.); Goldstream, *Macoun 18;* Alert Bay, Vancouver I., *Dawson* (N. Y., Pearson, W. H.,

Can. Hep. *16*, as *R. spicata*. 1890); Port Renfrew, *Skinner 3;* same locality, *G. Gibbs 6, 50, 59, 110, 129, 168*. Several of these localities are listed by Evans, A. W., Postelsia **1906:** 230. 1906.—WASHINGTON: Seattle, 1891, *Piper 20* (H.); Cathlamet, *Foster 492, 492b* (H.); Gate, *Foster 1960, 2019* (H.); near Aberdeen, *Foster 929* (H.), *945b* (H.). Several of these localities are listed by Haynes, C. C., Bryologist **12:** 69. 1909.—OREGON: Portland, 1888, *Underwood* (H.); Forest Grove, *Lloyd* (N. Y.); Silverton, *Foster 1391* (H.), *1384* (H.); North Silver Creek,

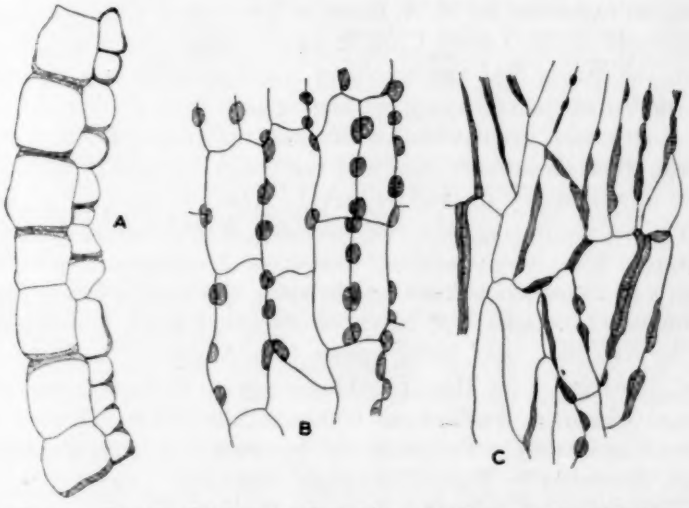

FIG. 2. RADULA BOLANDERI Gottsche. A. Cross-section of the capsule wall, × 450. B. Outer layer of the capsule wall, × 450. C. Inner layer of the capsule wall, × 450.

Marion Co., *Foster 1320* (H.). Austin's *R. spicata* was based in part on specimens from Salem, collected by E. Hall, but these specimens have not been available for examination.—CALIFORNIA: Mendocino City, *Bolander*, Stephani (N. Y.) TYPE; Muir Woods, *M. L. Campbell;* Lily Lake, *E. C. Sutliffe 33;* Marin Co., *Underwood & Cook*, Hep. Amer. *32;* Mill Valley, *Howe 3;* same locality, *Blasdale*, (H.); Marin Co., *McKean 32* (H.); near Lake Lagunitas, *E. C. Sutliffe* (H.); Mendocino, *Howe 549* (N. Y.); near Felton, *Underwood* (H.); Cazadero, *Howe* (N. Y.); Eureka, *Howe 918* (N. Y.); near McBride's, Mad River,

Humboldt Co., *Howe 1056* (N. Y.). M. A. Howe lists several of these localities in Mem. Torrey Club **7:** 159. 1899.

Austin's *Radula spicata*, although published earlier than the *Radula Bolanderi* of Gottsche, is a homonym of *Radula spicata* Mitten, and accordingly untenable in spite of the fact that Mitten's species has been reduced to synonymy under *Radula formosa* (Meissn.) Nees by Stephani.

Radula arctica is here included as a synonym since there is nothing in Stephani's description or figure of this plant to set it apart from the juvenile condition of *R. Bolanderi*. This opinion was first expressed by M. A. Howe in his work on the hepatics of California (Bull. Torrey Club **7:** 159. 1899). Stephani, however, maintains that the specimen is not juvenile but presents no further evidence to support his view.

R. Bolanderi agrees with *R. tenax* in several characteristics, such as the dioicous inflorescence and the entire absence of gemmae or of any tendency to shed its leaves. There is, however, no difficulty in separating the two species. Each species is characterized by a very definitely restricted geographical distribution. *R. Bolanderi* is known only along the Pacific Coast from California to Alaska. *R. tenax*, on the other hand, is restricted to the Atlantic Coast, being known from Maine to North Carolina. Pearson (Can. Hep. 1890) has reported *R. tenax* from Vancouver Island on the basis of material collected by Dawson at Alert Bay in 1885. This material, however, has been identified as *R. Bolanderi* by Evans (Postelsia **1906:** 230. 1906).

The points of difference between these two species are sufficiently marked to make a distinction readily possible. In *R. Bolanderi* the leaves are more decidedly imbricate, less widely spreading and not at all falcate. When compared with *R. tenax* the lobule in *R. Bolanderi*, in relation to the lobe, is larger, not at all or only slightly auriculate and extends less across the stem. In fact, there is no other North American form which possesses the narrowly spreading, spoon-shaped leaves with large lobules which characterize *R. Bolanderi*. In regard to the sexual structures there are also striking differences. The male inflorescence of *R. Bolanderi* is in most cases terminal, the bracts densely imbricate and more compact than in the case of *R. tenax*. The female inflorescence of *R. Bolanderi*, with usually two innovations, is readily distinguished from the pseudo-

lateral female flower of *R. tenax* with its widely separated female bracts.

3. RADULA POLYCLADA Evans, Bull. Torrey Club **41**: 607. 1915

Plants dull, yellowish green, becoming brown with age, 2–3 cm. in length, prostrate in loose mats: stems 0.2 mm. in width, profusely and regularly pinnately branched; branches 0.1 mm. in width, arising almost uniformly behind every leaf, widely spreading at an angle of 90°, 4–8 mm. in length, frequently bearing very short axes of the second order: stem leaves entire, somewhat imbricate, widely spreading at an angle of 70°–80°, and slightly falcate, the keel slightly arched; dorsal lobe of the stem leaves 0.95 × 0.65 mm., broadly ovate, convex and often revolute at the tip, the apex broadly rounded, the base slightly auriculate and free for one-third the distance, arching only slightly over the stem and only slightly decurrent; ventral lobe 0.4 × 0.35 mm., quadrate, appressed to the dorsal lobe, the base free about one-half its length, the free portion slightly auriculate at the point of fusion and arching only slightly over the stem, the free margin parallel to the keel, the apex obtusely angled, rhizoids entirely lacking; leaf cells plane, without definite trigones, occasionally somewhat thickened at the angles, the cuticle smooth, marginal cells 15 × 10 μ, median cells 22 × 17 μ, basal cells 30 × 25 μ; leaves of the primary axis more or less imbricate, dorsal lobe 0.45 × 0.35 mm., ovate, convex, less widely spreading than the stem leaves, the ventral lobe 0.2 × 0.1 mm., subquadrate, the free margin shorter than the keel; leaves of the secondary axes still less widely spreading, subequally bilobed: dioicous: female inflorescence terminal on a short branch of the first order, innovating at the base, the innovations two, more rarely one, and not fertile; female bracts large and wide spreading, the keel strongly incurved; dorsal lobe 1.4 × 0.8 mm., narrowly ovate, rounded at the apex and somewhat convex; dorsal lobe 0.85 × 0.65 mm., rounded at the apex and somewhat concave: perianth and male inflorescence not known.

TYPE LOCALITY: on rocks, Aats Bay, Alaska.

HABITAT AND DISTRIBUTION: on moist rocks and old logs; Alaska to Washington.

ILLUSTRATIONS: Bull. Torrey Club **41**: *figs. 2, 3.* 1915.

ALASKA: Sitka, 1894, U. S. Fish Commission; Aats Bay, *Frye 900*, TYPE; Unalaska, *Setchell et al. 1025;* Augustine Bay, *Frye 580, 586, Foster 758;* Ratz Harbor, *Frye 312;* Shipley Bay, *Foster 788;* Exchange Cove, *Frye 260;* Hidden Inlet, *Frye 73;* Prince of Wales Is., *Foster 1123*. Most of these are listed as

R. Bolanderi by Evans, A. W., Bull. Torrey Club **41**: 606. 1915.—BRITISH COLUMBIA: Port Renfrew, 1901, *G. Gibbs 59* (listed as *R. Bolanderi* by Evans, A. W., Postelsia **1906**: 230. 1906.); Ucluelet, *Macoun 43, 81, 113* (listed as *R. Bolanderi*).—WASHINGTON: near Olympic Hot Springs, Clallam Co., 1914, *Foster 2826*.

Compared with other North American species of *Radula* of the group in which gemmae are absent and in which there is no tendency to shed the dorsal lobe, *R. polyclada* most closely resembles *R. Bolanderi* and has often been confused with it as the

FIG. 3. RADULA POLYCLADA Evans. Portion of a female plant showing the female inflorescence terminal on a short branch of the first order with two sub-floral innovations, ventral view, × 18.

list of specimens indicates. Both species are restricted to the Pacific Coast region and, of the two, *R. polyclada* has the more northern range. In regard to the female inflorescence, size, and mode of branching, however, the two are strikingly different. *R. polyclada* is always larger and more regular in its branching habit. Moreover, in this species the leaves spread more widely from the stem, rhizoids are always entirely lacking and the apex of the lobule is less acutely angled. The most marked difference between these two species exists in connection with the female inflorescence. In *R. polyclada* the female flowers are always terminal on a short branch of the first order and

never at the apex of the stem or a leading branch as is the case in *R. Bolanderi*. The female bracts are somewhat larger than the stem leaves and more widely spreading while in *R. Bolanderi* they do not exceed the leaves of the stem in size and are more erect.

A decidedly more striking agreement exists between *R. polyclada* and the Siberian species, *R. prolifera* Arnell, known only from the type specimen, which was collected by H. Nilsson Ehle in 1898 at Bulkur, in the valley of the Lena.[3] The points of similarity and difference have been well brought out by Dr. Evans in his paper on the Alaskan Hepaticae[4] and need not be repeated here.

4. RADULA SULLIVANTII Austin, Bull. Torrey Club **6**: 19. 1875

Plants dull green, often with a golden yellow cast: stems 1–2 cm. in length and 0.15 mm. in width, rather profusely branched, pinnate and frequently bipinnate, the branches 1–3 mm. in length and 0.08 mm. in width, more or less wide spreading at first but later approaching the stem: leaves of the stem subimbricate, strongly falcate, wide spreading from the stem at an angle of 90°, the keel usually definitely arched; dorsal lobe 0.7 × 0.6 mm., broadly ovate, rounding out abruptly beyond the keel, the apex broadly rounded, the base free about half its length, not at all auriculate and usually spreading only a little over the stem, the line of attachment straight; ventral lobe 0.35 × 0.25 mm., rhomboidal, the outer margin straight, the anterior margin shorter than the keel, the apex obtuse, the base fused to the stem practically its entire length, a pronounced mammilliform swelling at the base of the lobule usually without rhizoids: leaves of the branches of the first order essentially like those of the stem; the dorsal lobe 0.55 × 0.4 mm., the base slightly auriculate; ventral lobe 0.35 × 0.2 mm., mammilliform outgrowth usually present: cells of the leaf usually thick-walled, often with distinct trigones; marginal cells 16 × 14 μ, median cells 17 × 14 μ, basal cells 17 × 14 μ: dioicous: the male inflorescence usually intercalary on the stem or a branch, rarely terminal, of two to four pairs of bracts, subimbricate, the keel strongly arched, the dorsal lobe 0.55 × 0.4 mm.; ventral lobe 0.4 × 0.2 mm., without rhizoid-bearing inflation: female inflorescence not known: vegetative propagation by means of caducous vegetative leaves, which occasionally give rise to thalloid growth before shedding.

[3] Ark. för Botanik **13**[2]: 12. *pl. 1. f. 1, 2.* 1913.

[4] Bull. Torrey Club **41**: 609. 1915.

TYPE LOCALITY: mountains of Georgia, *Sullivant, Lesquereux.*

HABITAT AND DISTRIBUTION: in depressed, dense mats on moist rocks and banks; known from Georgia and Alabama.

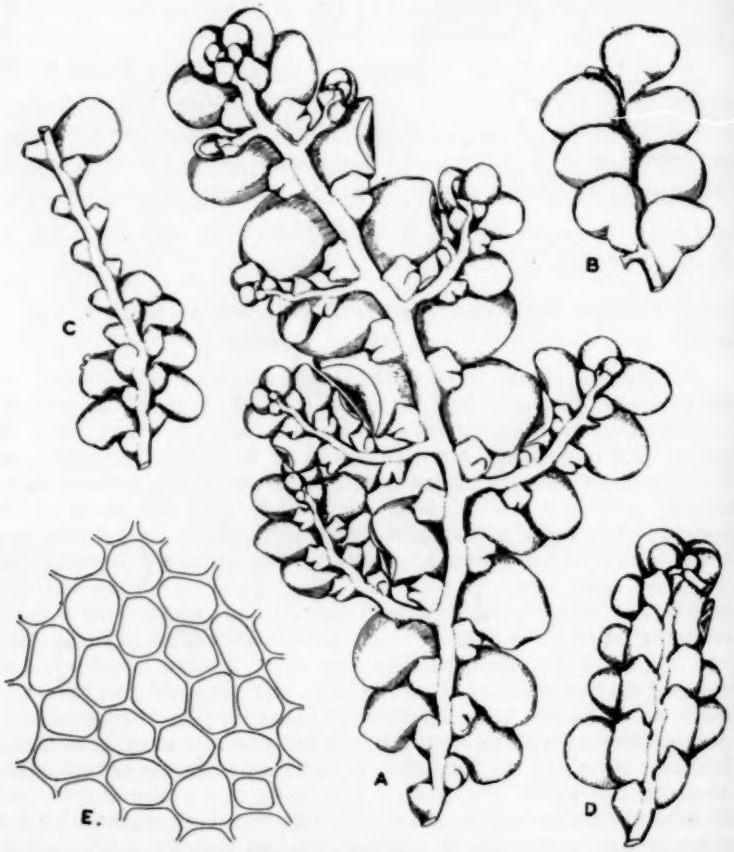

FIG. 4. RADULA SULLIVANTII Austin. A. Portion of a sterile plant, ventral view, × 18. B. Portion of the same, dorsal view, × 18. C. Portion of a sterile plant after shedding the dorsal lobes (Bruchblätter), ventral view, × 18. D. Portion of a male plant showing a terminal male inflorescence, ventral view, × 18. E. Leaf cells, × 450.

GEORGIA: without definite locality, 1843, *Sullivant & Lesquereux*, TYPE (distributed in Austin's Hep. Bor. Am. *88*[c]); Tallulah Falls, *Underwood* (distributed in Hep. Amer. *105*), *Small 90, 9181; Seymour,* Estotoah Falls, *Small* (distributed in Hep. E. N. Amer. 15).—ALABAMA: Fairhope, 1924, *Evans.*

This species belongs to a group which is characterized by a more or less pronounced tendency on the part of the leaves to shed their dorsal lobes, and *R. Sullivantii* has this tendency to a marked degree. The lobes are, in fact, Bruchblätter, which first give rise to flat, thalloid outgrowths from the lobe margin and then these develop into leafy shoots. Occasionally these thalloid bodies develop prematurely on the margin of a lobe before shedding. Under these circumstances they sometimes simulate gemmae, except for the fact that they do not separate from the lobes.

R. Sullivantii agrees with the preceding forms in its lack of discoid gemmae. It is, however, easily set apart from these by the presence of Bruchblätter, its strongly falcate leaves, and the fact that the base of the lobule is attached practically its entire length.

5. RADULA AUSTRALIS Austin, Bot. Gaz. 1: 32. 1876

Plants green, often with a tinge of brown: stems 1.5–3 cm. in length and 0.15 mm. in width, somewhat irregularly pinnately branched, the branches wide spreading at first and forming an angle of about 70° with the stem, later approaching the stem, frequently bearing a few scattered branches of the second order: stem leaves with a more or less marked tendency to shed the dorsal lobe, subimbricate, spreading from the stem at an angle of about 70°, falcate, the keel straight or slightly incurved; the dorsal lobe 1.5 × 1 mm., ovate or somewhat obovate, the apex broadly rounded, the base free about half its length, the free portion auriculate and arching across the stem and frequently beyond, the line of attachment oblique; ventral lobe 0.55 × × 0.55 mm., subquadrate, somewhat appressed to the dorsal lobe toward the apex, the anterior margin curved and occasionally with a fold in the region of the apex, the apex blunt but not broadly rounded, the base free usually about one-half its length, the free portion auriculate and extending from one-half to wholly across the stem, the line of attachment curved, a small rhizoid-bearing inflation usually present toward the base of the lobule: cells of the leaf thin-walled throughout; cells of the marginal portion 18 × 20 μ, cells of the median portion 20 × 22 μ, cells of the base 21 × 29 μ: leaves of the branches of the first order slightly different; the dorsal lobe 0.9 × 0.65 mm., narrower and usually more decidedly falcate than that of the stem leaf; the ventral lobe 0.3 × 0.25 mm., the anterior margin less broadly rounded, rhizoids only occasionally present; leaves of the branches of the second order essentially like those of the other branches but proportionately smaller: dioicous: male inflores-

cence intercalary on the main axis and the branches of the first and second orders, often appearing terminal due to the only slight vegetative growth at the tip; bracts in three to ten pairs, imbricate, much inflated toward the base, the keel strongly arched; dorsal lobe 0.55 × 0.25 mm., usually erect and rounded at the apex; ventral lobe 0.5 × 0.25 mm., the apex narrowly rounded: female inflorescence terminal on the stem or a branch, innovating on both sides, one innovation rarely developing beyond a rudimentary bud, the other often continuing the growth of the stem or other axis and frequently fertile; bracts erect; the dorsal lobe 0.85 × 0.45 mm., broadly rounded at the apex; ventral lobe 0.55 × 0.3 mm., obtusely angled at the tip; perianths 1–2 mm. long, cylindrical below, flattened above, shallowly two-lipped, the lips rather regularly and definitely undulate: capsule oval-cylindrical; the outer layer composed of regular, more or less isodiametric cells, square or broadly rectangular in cross-section, thickenings present on the vertical radial walls of certain cells occurring in definite sequence: median line of each valve formed by thin walls, three vertical lines on either side of more or less uniformly thickened walls, the next vertical line of thin walls, the next vertical line of uniformly thickened walls and the remaining two or three lines thin-walled throughout; inner layer of cells with horizontal bands of thickening on most of the vertical radial walls extending usually across the inner tangential wall: vegetative reproduction by means of caducous leaves.

TYPE LOCALITY: near Augusta, Georgia, *Sullivant*, 1845.[5]

HABITAT AND DISTRIBUTION: in dense depressed mats, frequently growing mixed with mosses or on the bark of trees; known from Georgia, Florida, Louisiana, Cuba and the Bahama Islands.

FLORIDA: without definite location, *Chapman 49* (N. Y.); Gainsville, *Wade & Robinson;* Blandton, *Underwood* (H.); Sanford, *Rapp 4* (H.), *24, 40* (H.) (Haynes, C. C., Bryologist **18:** 20. 1915); various hammocks in Dade Co., *Small et al. 1377, 1403, 1414, 1432, 1530, 1538, 2817, 2824, 3689, 5234, 5238, 5239, 5249, 5265, 5288, 5296, 5300, 5302, 6145, 6147, 6154, 6156, 6157, 6177, 6183, 6212, 6213, 6224, 6225, 6231, 6237, 7010, 7022, 7023, 7028, 7032, 7040;* Florida Keys, *Small et al. 1524, 1526, 1535, 1548, 1554, 3663, 7819.*—LOUISIANA: Bois Lobbé, 1891, *Langlois* (H.); Keystone, *Langlois* (H.).—CUBA: vicinity of San Diego de los Baños, Province of Pinar del Rio, 1915, *Brother Leon 5232b.*—BAHAMA ISLANDS: without definite location, *Northrop 349;* Maidenhead Coppice, New Providence,

[5] The type of *R. australis* has not been examined.

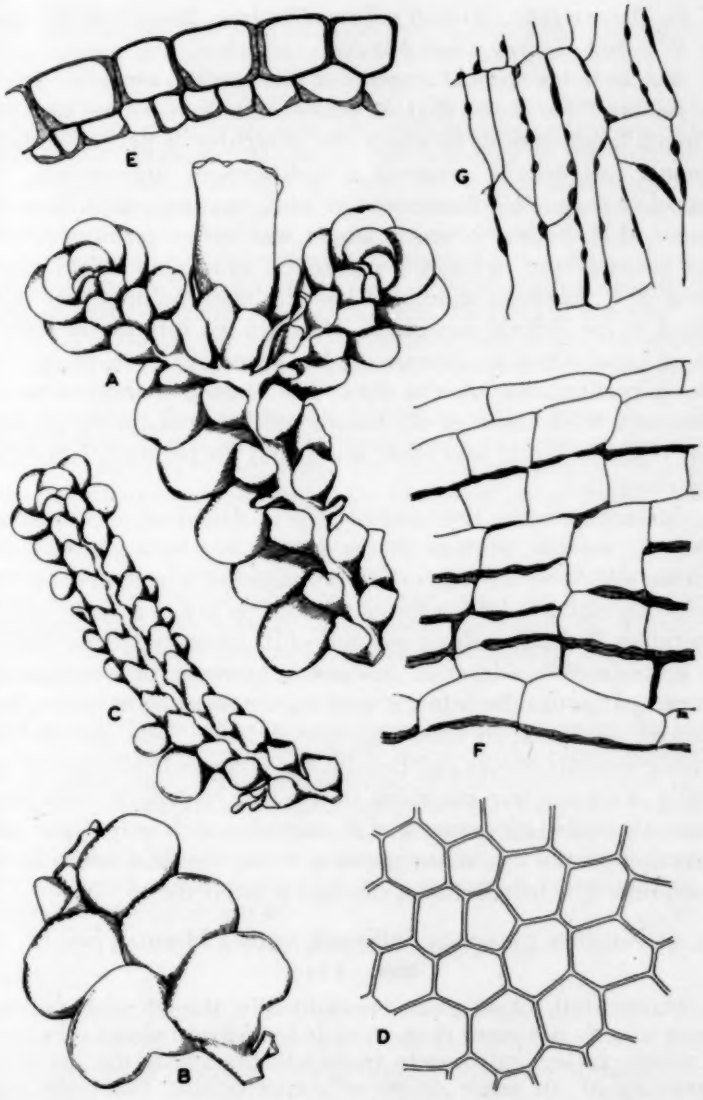

FIG. 5. RADULA AUSTRALIS Austin. A. Portion of a female plant showing the terminal flower with the two sub-floral innovations and mature perianth, ventral view, × 18. B. Portion of a sterile plant, dorsal view, × 18. C. Portion of a male plant showing the amentiform male inflorescence, ventral view, × 18. D. Leaf cells, × 450. E. Cross-section of the capsule wall, × 450. F. Outer layer of the capsule wall showing the median longitudinal line of the valve at M, × 450. G. Inner layer of the capsule wall, × 450.

E. G. Britton 3261, Nicholl's Town, Andros, *Brace 6880* (Evans, A. W., Bull. Torrey Club **38**: 206. 1911).

Austin in his original account of this species compares it with *R. pallens*. He shows that *R. pallens* differs, however, in being a much larger species in which the branching is never regularly pinnate but usually presents a dichotomous appearance. In regard to the male inflorescence he adds, in comparison, that the ament of *R. pallens* is much longer and never terminal. The last point is not actually a difference, as in none of the specimens of *R. australis* examined has the male inflorescence been found to be strictly terminal. It is always intercalary and in every case, when it appears to be terminal, close inspection shows proliferation at the tip. The leaves, moreover, when compared with those of *R. pallens* are more distinctly falcate, the lobule is larger and more acute, and the perianth is usually less elongate.

According to the treatment of North American species given here, *R. autralis* belongs in the group in which gemmae are lacking and in which vegetative propagation is accomplished by caducous leaves. Of the forms within this group it most nearly resembles *R. Sullivantii* on account of its strongly falcate leaves. *R. australis* differs from *R. Sullivantii*, however, in several characters. It is usually a larger and more robust form with a less marked tendency to shed the dorsal lobe. The dorsal lobe usually extends across and beyond the stem and the base of the lobule is always free one-third to one-half its length. Furthermore, the male inflorescence of *R. australis*, with only slight proliferation at the tip, often appears to be terminal while in *R. Sullivantii* it is usually more obviously intercalary.

6. RADULA OBCONICA Sullivant, Gray's Manual, Ed. 1: 688. 1848

Plants dull, olive green, occasionally tinged with yellow: stems usually not more than 1 cm. in length and about 0.15 mm. in width, rather indefinitely pinnately branched, the branches spreading at an angle of 80–90°, approaching the main axis above, separated by one to six leaves: stem leaves, except toward the tip, scarcely at all imbricate, spreading at an angle of 80°, slightly falcate, the keel slightly arched, straight, or more rarely slightly incurved; dorsal lobe 0.7 × 0.6 mm., ovate, convex, the apex broadly rounded, the base free one-third its length, the free portion subauriculate and arching only a short distance

over the stem, the line of attachment straight; ventral lobe 0.25 × 0.25 mm., subquadrate, the outer margin parallel to the stem, the apex narrowed into a blunt tip, the base fused to the stem one-third to one-half its length, the free portion not auriculate, the attachment straight, rhizoids present on a more or less pronounced inflation: leaves of the branches of the first order essentially like those of the stem; the dorsal lobe 0.45 × 0.4 mm., not at all falcate and slightly less widely spreading compared to the dorsal lobe of the stem-leaf; ventral lobe 0.2 × 0.2 mm.: leaves of the branches of the second order with relatively smaller lobes, about 0.2 × 0.1 mm.: cells of the leaf thin-walled and without trigones; marginal cells 16 × 13 μ, median cells 16 × 13 μ, basal cells 19 × 15 μ: heteroicous: male inflorescence a series of several pairs of bracts on the main axis below the female flower, or intercalary on a branch or subfloral innovation, the bracts smaller than the leaves, imbricate, with a strongly arched keel; dorsal lobe 0.45 × 0.25 mm., erect, rounded at the apex; ventral lobe 0.35 × 0.25 mm., the apex blunt, without rhizoids: female inflorescence terminal on the stem or a branch, with usually two innovations, the innovations wide spreading and frequently fertile; the bracts erect, scarcely smaller than the leaves; dorsal lobe 0.6 × 0.45 mm., ovate, the apex broadly rounded; the ventral lobe 0.35 × 0.25 mm., the apex narrowly rounded: perianth clavate, 2–2.5 mm. in length by 1 mm. in width, the mouth becoming slightly constricted at maturity; shallowly two-lipped, the lips entire; cells of the outer wall of the capsule with pronounced horizontal bands of thickening on the radial walls extending in some cases somewhat over the inner tangential wall, pronounced thickenings on the inner tangential wall usually only at the ends of cells; cells of the inner layer large, irregular, the radial walls sometimes thin but frequently more or less uniformly thickened, the outer tangential walls scarcely thickened but usually more or less pigmented with yellow, except for scattered unpigmented areas: vegetative reproduction by means of caducous leaves.

TYPE LOCALITY: in cedrinis palustribus prope Urbana Ohionis; arborea.

DISTRIBUTION AND HABITAT: on moist rocks and tree trunks, not a common species, known in all the Atlantic Coast States from Maine to Georgia, also in Ohio, Wisconsin, Minnesota and Arkansas.

ILLUSTRATIONS: Gray's Manual, Ed. 2, *pl. 8.* 1856, and Bryologist **21:** 59. *pl. 25.* 1918.

MAINE: Mt. Desert, Seal Harbor and Pemetic Mt., 1920, *A. Lorenz* (Rhodora **26:** 12. 1924).—VERMONT: Salisbury, 1911, *A. Lorenz* (Bryologist **21:** 57. 1918).—MASSACHUSETTS:

Sheffield, 1916, *A. Lorenz* (Bryologist **21:** 57. 1918).—CONNECTICUT: Hamden, 1918, *Evans;* North Branford, Huntington, Kent, Redding, North Stonington, *Evans;* Killingworth, Southington, *Nichols,* Watertown, Southington, East Haddam, *A. Lorenz;* Oxford, *Harger.* Many of these localities are listed by

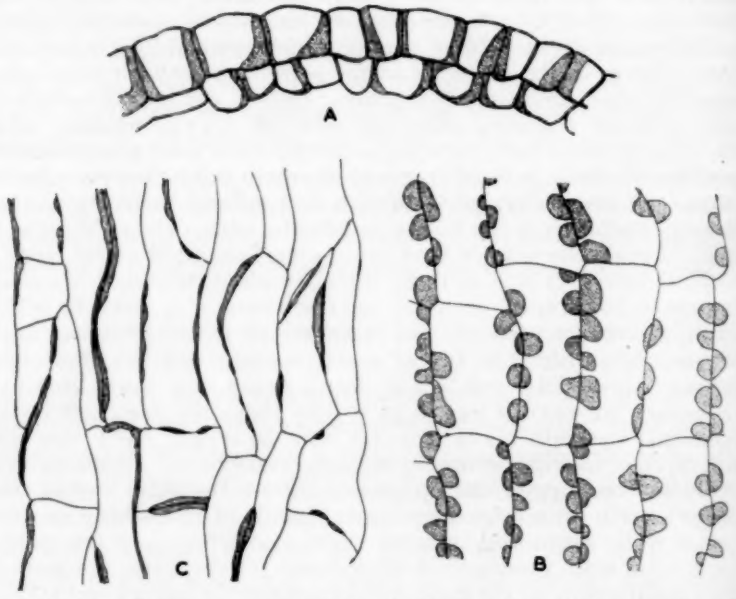

FIG. 6. RADULA OBCONICA Sull. A. Cross-section of the capsule wall, × 450. B. Outer layer of the capsule wall, × 450. C. Inner layer of the capsule wall, × 450.

A. Lorenz, Bryologist **21:** 57. 1918; and by Evans & Nichols, Bull. Conn. Geol. & Nat. Hist. Surv. **11:** 70. 1908.—NEW YORK: Ithaca, 1887, *Coville* (H.).—NEW JERSEY: without definite locality, *Sullivant 88.*—PENNSYLVANIA: Delaware Water Gap, 1871, *Garber* (Lorenz, A., Bryologist **21:** 57. 1918).—DISTRICT OF COLUMBIA: Rock Creek Park, 1889, *Waite 397* (H.); reported also from the same locality by Holzinger (Bryologist **10:** 92. 1907); Broad Branch, *Waite 520* (H.); Blogden's Mill, *Waite H6* (H.); without definite locality, *Holzinger* (Lorenz, A., Bryologist **21:** 57. 1918).—VIRGINIA: Spout Run, 1889, *Waite 488* (H.), *490* (H.); Nick's Creek, *E. G. Britton & A. M. Vail 45* (Lorenz, A., Bryologist **21:** 57. 1918; and Small & Vail, Mem. Torrey Club **4:** 193.

1893).—WEST VIRGINIA: Lick Run, 1909, *Sheldon 3970;* Burnt House, Randall, Albright, Marilla, *Sheldon 4228* (H.), *4237, 4004* (H.).—NORTH CAROLINA: Montreat, 1913, *Standley & Bollman 10160* (H.) (Standley, P. C., Bryologist **17:** 71. 1914); Winston-Salem, *Chapman 1056, 1176, 1773, 1073, 1673.* This species was also collected by Atkinson in 1901 at several stations in N. C. See Andrews, A. LeRoy, Bryologist **17:** 59. 1914.—GEORGIA: Tallulah, 1887, *Underwood & Cook*, Hep. Amer. *97;* same locality, *Underwood* (H.), *Seymour* (Lorenz, A., Bryologist **21:** 57. 1918).—OHIO: near Urbana, 1845, *Sullivant*, Musc. Alleg. *260* (N. Y.), TYPE; White's Gulch, Jackson Co., *Mrs. Bayard Taylor.*—WISCONSIN: Douglas Co., 1923, *Conklin 1965* (H.).—MINNESOTA: Cook Co., 1911, *Conklin 1135* (H.).—ARKANSAS: Swain, 1915, *Emig 1071* (Lorenz, A., Bryologist **21:** 57. 1918).

R. obconica agrees with all the preceding forms in its lack of true discoid gemmae. The tendency to shed the dorsal lobe exhibited by this plant shows more or less close relationship to *R. Sullivantii* and *R. australis.* It differs from these two species, however, in its heteroicous inflorescence and slightly falcate leaves. The mode of germination of the caducous leaves or Bruchblätter has been carefully followed by Miss Lorenz in her account of the species[6] and differs somewhat from that observed in the case of *R. Sullivantii.* After separation the lobe gives rise to small, massive, thalloid bodies along the margin which, after a few divisions, produce leafy shoots and ultimately new plants. The Bruchblätter of *R. Sullivantii*, on the other hand, give rise first to flat, thalloid bodies which soon produce the new plants.

7. RADULA COMPLANATA (L.) Dumortier, Comm. Bot. 112. 1822

Jungermannia complanata L. Sp. Pl. 1133. 1753.
Martinellius complanatus S. F. Gray, Nat. Arr. Brit. Pl. **1:** 691. 1821.
Radula alpestris Lindb.; Berggren, Bidrag till Skand. Bryol. 29. 1866.
Radula Hallii Aust. Bull. Torrey Bot. Club **6:** 19. 1875.
Radula Notarisii Steph. Hedwigia **23:** 129. 1884.
Radula Krausei Steph. Bot. Jahrb. **8:** 97. 1896.

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[6] Lorenz, A., Bryologist **21:** 58. 1918.

Stephanina complanata O. Kuntze, Rev. Gen. Pl. 839. 1891.
Stephanina alpestris O. Kuntze, *l. c.*

Plants pale to bright yellow green: stems 1–2 cm. in length and 0.15 mm. in width, irregularly once or twice pinnate, the branches 1–2 mm. in length and 0.1 mm. in width, few in number, spreading at an angle of 80°: stem leaves densely imbricate, the keel slightly arched, wide spreading and very slightly falcate; dorsal lobe 1.05 × 0.85 mm., broadly ovate, more or less convex, the apex broadly rounded, the base free about half its length, the free portion arching across the stem and usually beyond forming a definite auricle at the point of fusion with the stem, the line of attachment only slightly curved; ventral lobe 0.45 × 0.35 mm., quadrate, appressed to the dorsal lobe, the apex rounded or obtusely angled, rarely slightly prolonged into a blunt tip, the base free one-half to one-third its length, slightly auriculate at the point of fusion with the stem, the line of attachment straight, rhizoid-bearing cushion usually present near the base: leaves of the branches of the first order essentially like those of the stem; the dorsal lobe 0.6 × 0.4 mm. usually more erect and not at all falcate: ventral lobe 0.2 × 0.25 mm., rhizoids present: cells of the leaf comparatively thin-walled, occasionally slightly thickened at the angles; cells of the margin 22 × 15 μ, median cells 20 × 18 μ, and basal cells 22 × 19 μ: inflorescence paroicous: female inflorescence terminal on the stem or a leading branch, usually innovating at the base, the innovations rarely two, wide spreading and frequently fertile, the bracts erect with unequal lobes; dorsal lobe 1.2 × 0.9 mm., the apex broadly rounded; ventral lobe 0.75 × 0.4 mm.: male inflorescence a series of two to four pairs of bracts, imbricate, the keel strongly arched; dorsal lobe 0.9 × 0.75 mm. broadly ovate, the base free about half its length, auriculate and arching nearly across the stem; ventral lobe 0.55 × 0.45 mm., subquadrate, the apex obtusely angled, the base free one-half its length, auriculate: perianth 1.5–2.5 mm. in length, obconical, strongly flattened above, the mouth truncate, obscurely 2-lipped, the lips slightly obscurely repand: vegetative propagation by means of discoid gemmae frequent on the dorsal lobes of leaves, male and female bracts: outer layer of cells of the capsule wall composed of more or less regular rectangular cells with pronounced bands of thickening on alternate radial walls, the thickenings heavier toward the outer surface and varying considerably in height: cells of the inner layer irregular, thin-walled with no visible thickenings on the radial walls, reinforced with delicate horizontal bands on the inner tangential walls, usually 5–8 bands in each cell.

TYPE LOCALITY: in Europa ad arborum truncos.

HABITAT AND DISTRIBUTION: common on bases of trees and

on rocks in somewhat damp and well sheltered places; known practically throughout North America, Europe, Northern Asia, and Northern Africa.

ILLUSTRATIONS: Hooker, Brit. Jung. *pl. 81.* 1816; Macvicar, Student's Handbook of British Hepatics 387. 1912; Müller; Rabenhorst's Kryptogamen-Flora 6^2: *f. 158.* 1912–16.

In view of the fact that *Radula complanata* is so well known, it has been considered unnecessary to list definite stations for this species. The collection of *Radulae* in the herbarium of Yale University contains 170 specimens of *Radula complanata*

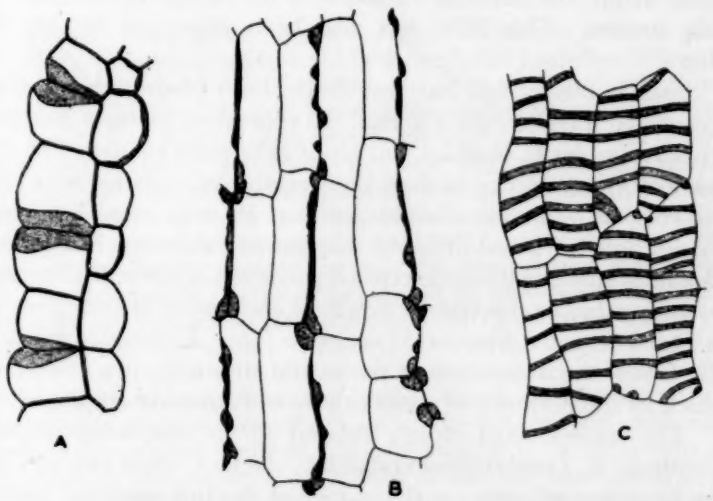

FIG. 7. RADULA COMPLANATA (L.) Dumort. A. Cross-section of the capsule wall, × 450. B. Outer layer of the capsule wall, × 450. C. Inner layer of the capsule wall showing transverse striae on the inner tangential walls, × 450.

from Alaska, Canada, Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Virginia, West Virginia, North Carolina, Florida, Louisiana, Michigan, Wisconsin, Minnesota, Montana, Colorado, Idaho, Arizona, Washington, Oregon, and California.

Two American forms, *R. Hallii* Austin and *R. Krausei* Stephani which have been proposed as new, are here included in the list of synonyms. *R. Hallii*, based on material collected

by E. Hall in Oregon, was said to differ in the following points: the leaf apices more incurved, involucral bracts smaller and more equally bilobed, and the perianth larger with several other minor differences. However, the type which is in the herbarium of the New York Botanical Garden, has been examined and reveals none of these differences sufficiently marked to warrant the recognition of a new species. On the other hand, the Alaskan type of *R. Krausei* has not been seen, yet material collected by Leiberg in Idaho and determined by Stephani as *R. Krausei* exhibits only the slight variations which may well come within the limits of variation of the recognized concept of this species. This view has also been expressed by M. A. Howe.[7]

Radula complanata has the distinction of being the earliest recognized member of the genus. In vegetative features it somewhat resembles *R. obconica*, but tends to be more robust. The absence of any tendency to shed the dorsal lobe, together with the presence of numerous discoid gemmae, at once sets these two species apart. In addition to this, the inflorescence of *R. complanata* is almost without exception paroicous, while in *R. obconica*, our only other monoicous species, male and female branches occur in addition to the bisexual branches. Since *R. complanata* usually fruits, the disposition of the sexual structures is a character which in the majority of cases can be conveniently employed.

The species most closely related to *R. complanata* is the European *R. Lindbergiana* Gottsche. In fact, these two species can be separated only on the nature of the inflorescence, which is dioicous in *R. Lindbergiana*. In this latter species, even when not actually in fruit, sterile archegonia may be found at the apices of the stems or branches, and the swollen, subinvolucral, male bracts, present in the paroicous *R. complanata*, are entirely lacking. Both Schiffner[8] and Jack,[9] who have made critical studies of *R. complanata* in Europe, have described plants in which are combined both the paroicous and heteroicous arrangements of the sexual structures. With this condition existing it would be impossible to assign with any certainty a single isolated female branch of a plant to either *R. complanata* or *R. Lind-*

[7] Mem. Torrey Bot. Club **7:** 160. 1899.
[8] Schiffner, V. Lotos **60:** 72. 1912.
[9] Jack, J. B. Flora **64:** 357. 1881.

bergiana. However, up to the present time, no heteroicous individuals of *R. complanata* have been noted in America. In fact careful inspection of all the North American material of *R. complanata*, which has been available, has failed to disclose any plants in which the inflorescence is other than paroicous. Therefore, it may be assumed from the evidence at hand that *R. Lindbergiana* is strictly an Old World species and does not occur in this country.

8. RADULA CALOOSIENSIS Austin, Bull. Torrey Club **6**: 301. 1879

Plants yellow green: stems 1–1.5 cm. in length and 0.1 mm. in width, somewhat irregularly branched, the branches 1–5 mm. in length and 0.06 mm. in width, at first wide spreading and forming an angle of 80–90°, later approaching the axis, separated by two to four leaves: stem leaves spreading at an angle of 60°, somewhat densely imbricate, the keel slightly arched; dorsal lobe 0.95 × 0.7 mm., broadly ovate, the apex broadly rounded, the base free one-third to one-half its length, the free portion auriculate and arching across and slightly beyond the stem, the line of attachment slightly curved; the ventral lobe 0.35 × 0.3 mm., subquadrate, flat and appressed to the dorsal lobe, the terminal portion somewhat prolonged into a more or less acute tip, the base free about one-third its length, the free portion slightly auriculate and extending a short distance across the stem, the line of attachment oblique; rhizoids usually present on an inflated cushion near the base of the lobule : leaf cells uniformly thin-walled; cells of the leaf margin 15 × 13 μ, cells of the median portion 20 × 18 μ, cells of the leaf base 33 × 20 μ; leaves of the axis of the first order essentially like those of the stem, the keel slightly more arched; the dorsal lobe 0.8 × 0.65 mm., the ventral lobe 0.3 × 0.3 mm.; leaves of the axis of the second order proportionately smaller and less widely spreading: dioicous: male inflorescence terminal on a branch, apparently not proliferating, consisting of two or three pairs of densely imbricated bracts, the individual bracts much inflated at the base; the dorsal lobe 0.7 × 0.45 mm., erect, rounded at the apex; the ventral lobe 0.5 × 0.25 mm., the apex subacute: female inflorescence terminal on the stem or a subfloral innovation; bracts smaller than the leaves; the dorsal lobe 0.7 × 0.55 mm., erect, broadly rounded at the tip; the ventral lobe 0.4 × 0.25 mm., erect, rounded at the apex: perianths not seen: discoid gemmae abundant on the dorsal lobes of the stem and branch leaves, as well as on the male and female bracts.

TYPE LOCALITY: Caloosa, Florida, March, 1878.

HABITAT AND DISTRIBUTION: growing closely appressed to the bark of trees: known at present from three stations in Florida, two in Alabama and one in Louisiana.

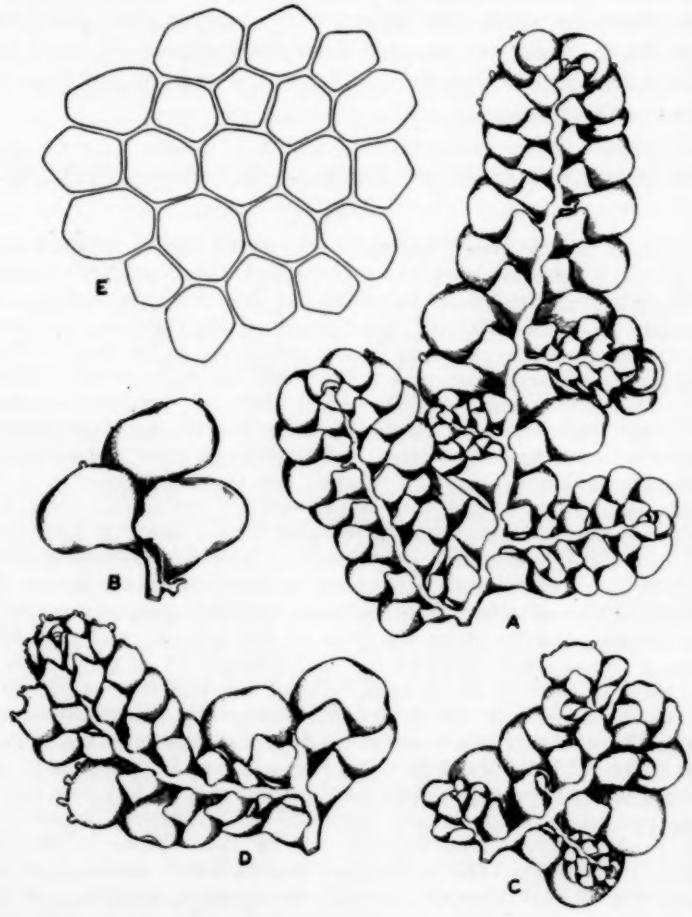

FIG. 8. RADULA CALOOSIENSIS Austin. A. Terminal portion of a sterile plant showing discoid gemmae on the margins of the dorsal lobes, ventral view, × 18. B. Portion of the same, dorsal view, × 18. C. Portion of a female plant showing the terminal flower with two sub-floral innovations, ventral view, × 18. D. Portion of a male plant showing the terminal male inflorescence, ventral view, × 18. E. Leaf cells, × 450.

FLORIDA: Caloosa, 1878, *Austin*, TYPE; Blandton, *Underwood 223;* Sanford, *Rapp 72* (H.), *86.*—ALABAMA: near Fort Payne, 1905, *Harper* (N. Y.); Fairhope, *Evans.*—LOUISIANA: Bois Lobbé, 1890, *Langlois* (H.).

R. caloosiensis was considered a distinct species until 1910 when Stephani, in his synopsis of the genus,[10] reduced it to synonymy with *R. australis.* Although *R. caloosiensis* has without doubt, some characters in common with *R. australis*, there are several points of distinct difference which form sufficient basis for re-establishing the species. *R. caloosiensis* usually bears abundant discoid gemmae, its leaves are not at all falcate, and the lobe is considerably larger in relation to the lobule, narrower and more tapering, and with no tendency to break apart.

When only vegetative features are considered there is very close agreement between *R. caloosiensis* and the monoicous *R. complanata.* In fact, there are really no well-defined characters, aside from those relating to the inflorescence, which can be employed to separate these two species when sterile. There is, however, one difference in habit that often can be utilized: *R. complanata* invariably bears flowers even when gemmae are present in abundance; *R. caloosiensis*, on the other hand, rarely fruits, and usually when sterile bears numerous gemmae.

9. **Radula Langloisii** sp. nov.

Plants dull green and slightly tinged with yellow: stems 1–2 cm. in length and 0.1 mm. in width, irregularly pinnately and bipinnately branched, the branches wide spreading at first and later converging toward the main axis or bending backward, the growth of the plant frequently continued by a leading branch: stem leaves decidedly imbricate toward the growing tip, less so on older portions of the stem, wide spreading, the keel straight or more rarely only slightly arched; the dorsal lobe 0.75 × 0.6 mm., broadly ovate, the apex rounded, the base free about one-half its length, the free portion auriculate and on younger portions of the plant arching across and some distance beyond the stem, the line of attachment curved; ventral lobe 0.25 × 0.25 mm., subquadrate, appressed to the lobe, the outer free margin and the anterior free margin slightly incurved, the apex slightly prolonged into a blunt tip, the base free about one-

[10] Stephani, F., Sp. Hep. **4**: 216. 1910.

fourth its length, the free portion arching a little over the stem, auriculate, the line of attachment nearly straight; rhizoids usually present on the lower portion of the lobule; leaves of the more vigorous branches of the first order essentially like those of the stem, those of the less vigorous branches of the first order and those of the branches of the second order more erect, the lobule larger in proportion to the lobe, more inflated at the base and the keel slightly more arched: cells of the leaf uniformly thin-walled; cells of the leaf margin 18 × 18 μ, cells of the median portion of the leaf 20 × 18 μ, cells of the basal portion 23 × 18 μ: dioicous: male inflorescence intercalary on the stem or a branch, consisting of one to four pairs of subequally bilobed bracts, the bracts decidedly imbricate, much inflated at the base, and the keel strongly arched; dorsal lobe 0.55 × 0.25 mm., erect, broadly rounded at the tip, somewhat constricted above the keel, the base free one-half its length, the free portion extending somewhat across the stem and beyond; the ventral lobe 0.45 × 0.2 mm., erect, rounded at the tip, the base free two-thirds its length, the free portion arching slightly over the stem: female inflorescence terminal on the stem and branches of the first and second orders, with usually a single innovation, the innovation frequently fertile; bracts erect, usually somewhat unequal in size, the lower slightly larger, the keel incurved; the dorsal lobe 0.85 × 0.6 mm., broadly and regularly ovate, the apex broadly rounded; ventral lobe 0.55 × 0.45 mm., somewhat irregular in outline, rounding out abruptly above the keel, the apex blunt: immature perianth 0.5–0.8 mm. in length and 0.8 mm. in width, strongly flattened, very definitely two-lipped, the cleft shallow on one side and extending usually one-third to one-half the length of the perianth on the other side, the lips very coarsely undulate; the mature perianth about 1.5 mm. in length and 0.75 mm. in width, somewhat contracted at the mouth, deeply cleft on one side: mature capsules not seen: vegetative propagation by means of occasional discoid gemmae borne on the lobes of the leaves and on the lips of the perianth.

Type collected at Keystone, Louisiana, 1891, *Langlois* (herbarium of C. C. Haynes).

HABITAT AND DISTRIBUTION: growing closely appressed to the bark of trees or mixed with mosses; known only from North Carolina, South Carolina and Louisiana.

NORTH CAROLINA: Jackson Springs, Moore Co., 1905, *C. C. Haynes* (H.).—SOUTH CAROLINA: Summerville, 1889, *C. DuBois* (H.).—LOUISIANA: Coteau, 1890, *Langlois* (H.); Keystone, *Langlois* (H.), TYPE; Bois Lobbé, *Langlois* (H.).

This species somewhat closely resembles *Radula complanata* so far as vegetative features are concerned. In fact, it is difficult

to distinguish between sterile plants of the two species. There are, however, slight differences of a vegetative kind. The leaves of *R. complanata* are always more decidedly imbricate and the lobe does not extend across the stem as far as it does in the other. In fertile material a distinction is a simple matter as *R. Langloisii* is dioicous while *R. complanata* is monoicous. This disposition of sexual organs is a feature that usually can

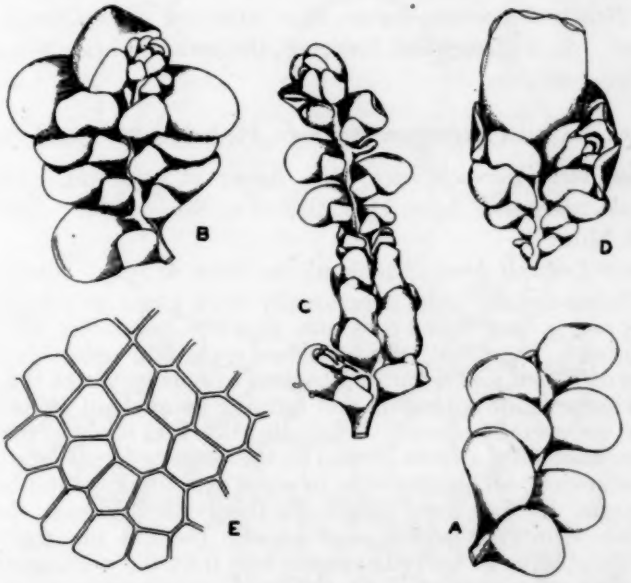

FIG. 9. RADULA LANGLOISII Castle. A. Portion of a sterile plant, dorsal view, × 18. B. Portion of a female plant showing the female inflorescence with a single sub-floral innovation, ventral view, × 18. C. Portion of a male plant showing the intercalary male inflorescence, ventral view, × 18. E. Leaf cells, × 450.

be employed in separating the two, as *R. complanata* almost always fruits. Moreover, when sterile portions are involved, the abundance of discoid gemmae in *R. complanata* will usually set it apart from the other, in which gemmae are only rarely produced. The female inflorescence suggests that of *R. australis* but differs in that the lobe of the female bract is more broadly ovate and the lobule is larger in proportion to the lobe. The male inflorescence, which is always intercalary on the stem or a

branch, is quite distinct from that of any of our other species. The bracts are few in number, very decidedly imbricate, and become successively smaller from the base of the inflorescence upward. The ventral lobe approaches the dorsal lobe in size. The latter is erect and projects very little to the side. Moreover, there is a pronounced constriction in each bract just above the inflated basal portion. The most striking character possessed by this species is found in connection with the perianth. In all the North American forms this structure is shallowly two-lipped. In *R. Langloisii*, however, the perianth is always deeply cleft on one side.

10. RADULA ANDICOLA Stephani, Hedwigia **23**: 114. 1884

Radula viridi-aurea Spruce, Hep. Amaz. et And. 324. 1885.
Radula xalapensis Aust. Hep. Bor.-Am. *88b*. 1874. Not Nees & Mont.
Radula Lescurii Aust.; Stephani, Sp. Hep. **4**: 191. 1910.

Plants usually pale, occasionally dark green in color: stems 1–2.5 cm. in length and 0.15 mm. in width, pinnately but never bipinnately branched, the branches spreading obliquely at an angle of 70-80° and separated by two to four leaves of the stem: stem leaves wide spreading and forming an angle of 80–90° with the stem, usually densely imbricate; the keel slightly incurved and occasionally a little arched in the center; dorsal lobe 1.5 × 1 mm., ovate, arching usually to some extent across and beyond the stem, its base free about one-third the distance, the free portion forming a pronounced auricle, the line of attachment slightly oblique or curved; ventral lobe 0.85–0.7 mm., quadrate, its outer margin parallel to the axis, apex subacute, anterior margin nearly horizontal and usually with a fold, the base free one-half its length, the free portion auriculate and arching nearly across the stem, the line of attachment straight, usually with a small, somewhat pointed swelling bearing rhizoids: leaf cells thin-walled throughout; cells of the leaf margin 18 × 15 μ, median cells 18 × 15 μ, basal cells 25 × 20 μ: male and female inflorescences not known: vegetative propagation by means of discoid gemmae abundant on the margins of the dorsal lobe.

TYPE LOCALITY: America tropica, Ecuador, leg. Krause (Herb. Jack); Silla de Caracas, leg. Birschall (Herb. Kew); Rio Janeiro, leg. Jan Deventer (Herb. Sande-Lacoste).

HABITAT AND DISTRIBUTION: in depressed, dense mats on moist rocks; throughout tropical America, north to District of Columbia and south to Rio de Janeiro.

DISTRICT OF COLUMBIA: Rock Creek Park, 1890, *Waite H44* (H.). This specimen is not typical since the majority of the lobules extend only part way across the stem. An occasional lobule, however, approaches the characteristic form.—WEST VIRGINIA: Beaver Spring, 1892, *Millspaugh 1551;* Huntington,

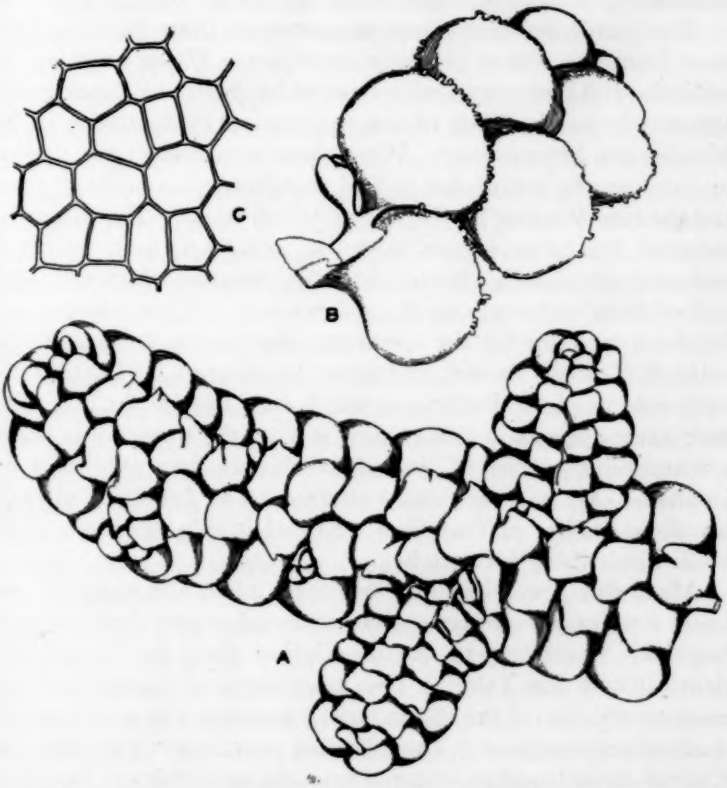

FIG. 10. RADULA ANDICOLA Steph. A. Terminal portion of a sterile plant, ventral view, × 18. B. Dorsal view of the same, × 18. C. Leaf cells, × 450.

Plymale 29. Both these specimens, like the preceding, possess lobules which in the majority of cases are not typical. Many, however, are sufficiently characteristic to justify including the forms under this species.—NORTH CAROLINA: Woodfin Falls, near Balsam, 1919, *Andrews 278* (Bryologist **24**: 53. 1921); Moore Spring, Hoke Co., *Schallert 42* (H.).—GEORGIA: Tallulah

Falls, 1874, *Austin*, Hep. Bor.-Am. *88b* (distributed as *R. xalapensis* Mont.); Grand Chasm and Glen Ella Spring, vicinity of Tallulah Falls, *Seymour;* Toccoa Falls, *Underwood & Cook*, Hep. Amer. *104* (distributed as *R. xalapensis* Mont.).—CUBA: Monte Verde, *Wright.*—PERU: San Miguel, 1911, *Foote 44* (Evans, A. W. Trans. Conn. Acad. **18:** 313. 1914).

The sterile but gemmiparous specimens from Tallulah Falls have been the source of much confusion. Those collected by Sullivant and Lesquereux were referred by Austin to *R. xalapensis* apparently on the basis of the description by Gottsche in his Mexikanske Levermosser. When these specimens were studied by Lindberg he was unable to find any distinction between them and the rare *R. voluta* Taylor of the British Isles.[11] He, therefore, included the latter species under *R. xalapensis* as a synonym and cited also Lindig's material from Colombia, which Gottsche had already referred to *R. xalapensis.*[12] Many years later Stephani took up for the specimens distributed by Austin the name *R. Lescurii* Austin, giving as the place of publication the sixth volume of the Bulletin of the Torrey Botanical Club. No such name appears in this volume so that the species was really a manuscript species of Austin which was first published by Stephani. He had previously referred to *R. Lescurii*[13] without describing it, but at that time regarded it as a synonym of *R. mollis* Lindenberg & Gottsche.

Meanwhile, Stephani had described under the name *R. andicola* a series of specimens without sexual organs from tropical America. According to the description these are apparently identical with the Tallulah Falls specimens, although Stephani made no mention of the characteristic gemmae which are usually so abundantly present. The following year Spruce published his *R. viridi-aurea* based on material from the mountains of Ecuador. This also was described from sterile specimens and again no mention was made of gemmae. In his Species Hepaticarum Stephani included *R. viridi-aurea* as a synonym of *R. Lescurii* and extended the range of this species to Bolivia on the south and Costa Rica on the north. In citing material from Peru,

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[11] Acta Soc. Sci. Fenn. **10:** 401. 1875.
[12] Ann. Sci. Nat. Bot. V. **1:** 143. 1864.
[13] Hedwigia **23:** 157. 1884.

Evans noted for the first time discoid gemmae in this species and compared them with those of *R. complanata*.[14]

Unfortunately it has been impossible to obtain for examination the type specimens of *R. andicola* and *R. viridi-aurea*. However, in view of the wide range which Stephani assigns to this species and the close agreement between the Peruvian specimens and those from Tallulah Falls it seems justifiable to include *R. Lescurii* among the synonyms of *R. andicola*.

R. andicola, although distinct as a species, stands in close relationship to several other species such as *R. voluta* and *R. mollis*. When compared with *R. voluta* the two are found to differ widely in respect to the lobule, which extends to a much greater distance across and beyond the stem in *R. voluta*. The keel in *R. andicola*, moreover, is almost invariably slightly incurved while in *R. voluta* it is often straight or slightly arched. *R. andicola*, furthermore, usually bears abundantly discoid gemmae, while in *R. voluta*, gemmae are but rarely present.

Stephani, in his original synopsis of the genus,[15] suggests that *R. mollis* Lindenberg & Gottsche and *R. Lescurii* Austin are synonyms. Again comparison of the two reveals marked differences. The lobules of *R. mollis* are still larger and extend even farther across the stem, the free basal portion is usually angular rather than broadly rounded, the leaves are more densely imbricate and gemmae are few in number.

Without doubt *R. andicola*, *R. voluta* and *R. mollis* are members of a group of more or less closely related species. A fourth member of this group is *R. ramulina* Taylor. Here also the most striking difference exists in relation to the lobule which extends to a greater distance across and beyond the stem. Moreover, this species is huge when compared to *R. andicola* and up to the present time is not known to produce gemmae.

11. RADULA FLACCIDA Lindenberg & Gottsche; G. L. N. Syn. Hep. 726. 1847

Radula epiphylla Mitt.; Stephani, Hedwigia **23:** 113. 1884.
Stephanina flaccida O. Kuntze, Rev. Gen. Pl. 839. 1891.

Plants dull green: stems 0.5–1.5 cm. in length and 0.06 mm. in width, rather indefinitely pinnately and rarely bipinnately

[14] Trans. Connecticut Acad. Arts & Sci. **18:** 313. 1914.
[15] Hedwigia **23:** 157. 1884.

branched, the branches 2–5 mm. in length and 0.05 mm. in width, spreading from the stem at an angle of 50–60° and separated by two to five leaves: stem leaves subimbricate, spreading at an angle of 60–70°, usually only slightly falcate, the keel straight or slightly arched; dorsal lobe 0.9 × 0.7 mm., ovate or somewhat obovate, flat, the apex broadly rounded, the base free about one-third its length, the free portion auriculate and arching entirely across the stem but seldom beyond, the line of attachment straight; ventral lobe 0.3 × 0.2 mm., the apex extended into a long, blunt-tipped, frequently curved apex, the base fused to the stem almost its entire length, the line of attachment straight, rhizoids numerous on a pronounced mammilliform swelling: leaves of the axis of the first order essentially like those of the stem; dorsal lobe 0.6 × 0.5 mm.; ventral lobe 0.13 × 0.16 mm., with rhizoids: leaf cells comparatively thin-walled and without trigones; marginal cells 16 × 12 μ, median cells 23 × 15 μ, and basal cells 23 × 15 μ: dioicous: male inflorescence a long, slender, ament, slightly tapering toward the apex, terminal on the stem or branch of the first order; the bracts in three to fifteen pairs, imbricate, much inflated toward the base, the lobes subequal, the keel strongly arched; dorsal lobe 0.4 × 0.15 mm., erect, rounded at the tip; ventral lobe 0.3 × 0.15 mm., obtusely angled at the tip, without rhizoids: female inflorescence terminal on the stem, innovating on both sides, the innovations wide spreading, short and sterile or frequently more elongate and fertile; bracts smaller than the leaves; the keel somewhat inwardly curved; dorsal lobe 0.55 × 0.35 mm., rounded at the apex; ventral lobe 0.35 × 0.15 mm., without an elongate tip, rhizoids absent: perianth 1–1.5 mm. in length, in outline trumpet-shaped with a slightly flaring mouth, terete at the base and strongly flattened above, the mouth shallowly two-lipped, the lips coarsely and irregularly but faintly crenate; the outer layer of the capsule composed of regular more or less isodiametric cells as in *R. complanata*, the vertical radial walls and frequently the horizontal walls strengthened by continuous, more or less regular additional layers of wall material, the tangential walls without thickenings; the inner layer composed of large, thin-walled cells, with the radial walls frequently thickened by uniform thin layers, no thickenings visible on the tangential walls: vegetative reproduction by means of circular, discoid gemmae, borne dorsally in small numbers on the upper margins of the dorsal lobes, one cell in thickness, at maturity 0.5–0.8 mm. in diameter, with several, three to eight, usually five, large cells on the margin representing initial cells, constricted below into a funnel-like structure at the base of which six to eight elongate cells remain attached.

TYPE LOCALITY: in terris Mexicanis prope Hacienda de Fovo foliis *Psychotriae* cuiusdam arctissime irrepens (Liebman).

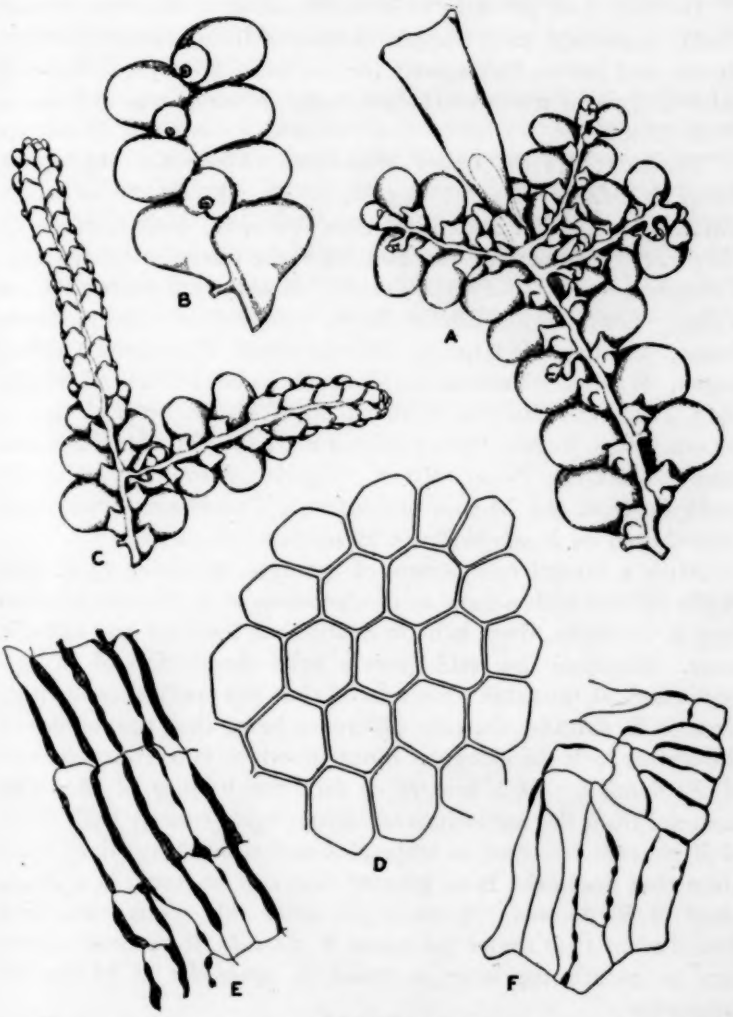

FIG. 11. RADULA FLACCIDA Lindenb. & Gottsche. A. Portion of a female plant showing the terminal inflorescence with mature perianth and two sub-floral innovations, ventral view, × 18. B. Portion of a sterile plant showing the large, discoid gemmae on the margins of the dorsal lobes, dorsal view, × 18. C. Portion of a male plant showing the terminal, amentiform, male inflorescence, ventral view, × 18. D. Leaf cells, × 450. E. Outer layer of the capsule wall, × 450. F. Inner layer of the capsule wall, × 450.

HABITAT AND DISTRIBUTION: scattered or in depressed mats, closely appressed to the upper surface of living leaves of trees, shrubs and herbs; throughout the lowlands of tropical America extending as far north as Dade County, Florida; also in tropical West Africa.

FLORIDA: Hattie Bauer Hammock, Dade County, 1915, *Small & Mosier* (Evans, Bryologist **20:** 24. 1917).—GUATEMALA: vicinity of Secanquim, Alta Verapaz, 1905, *Maxon & Hay 3211.*—CUBA: Monte Toro, *Wright* (distributed in Hep. Cubenses).—JAMAICA: Bath, 1903, *Evans 332;* Green River Valley, *Evans 212.*—PORTO RICO: vicinity of Cayey, 1900, *Evans;* vicinity of Utuado, *Wheeler 992;* Mayaquez, *Heller;* Jagua, *Whetzel.*—TRINIDAD: Maraval Valley, Port of Spain, 1913, *Thaxter;* vicinity of Arima, 1920, *E. G. Britton et al. 641.*—BRAZIL: Rio Negro, *Spruce* (distributed in Hepaticae Spruceanae).—AFRICA: Niger River, Nigeria, *Barter* (type of *R. epiphylla* from the Mitten herbarium); Cameroons, *Dusen 427* (distributed as *R. epiphylla* in Hepaticae Africanae).

After a careful comparison of the type specimen of *R. epiphylla* Mitten with a number of specimens of *R. flaccida* Lindenberg & Gottsche, there is little doubt that they are one and the same. Stephani (*loc. cit.*) gives a brief description of *R. epiphylla* and, at the same time, admits that this species stands very close to *R. flaccida*, the only difference being that the lobules of the former lack the elongate, blunt tip which is so characteristic of *R. flaccida*. As a matter of fact the lobules of the type material from the herbarium of Mitten agree exactly with those of *R. flaccida* collected in tropical America and any slight variation that does exist is no greater than can be found in a single plant of *R. flaccida*. Accordingly, since this species was first described in 1847 under the name *R. flaccida*, it becomes necessary to reduce the later proposed *R. epiphylla* of Mitten to synonymy.

Aside from the extraordinary and almost constant epiphyllous habit of *R. flaccida*, this species is characterized by the production of remarkable bodies for vegetative reproduction. These structures are large discoid gemmae, which arise from the margins of the lobes on the dorsal side of the plant. Miss Ruth Williston has very ably described these gemmae and their development in a paper entitled "Discoid gemmae in Radula."[16]

[16] Bull. Torrey Club **39:** 329–339. *f. 1–37.* 1912.

Almost coincident with this account appeared a similar description by Goebel[17] based on African material bearing the name *R. epiphylla* Mitten.

The epiphyllous habit is, apparently, not common among the species of *Radula*. *R. flaccida* is the only one of the species of this genus found within the United States which grows uniformly upon living leaves. There are, however, several other epiphyllous *Radulae* outside the range of this work: *R. Grevilleana* Taylor and *R. sienocalyx* Mont. throughout tropical America and *R. mammosa* Spruce reported only from Bolivia. It is quite possible that one or more of these may extend to tropical Florida as in the case of *R. flaccida*.

YALE UNIVERSITY

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[17] Flora **104**: 156. 1912.

Studies on the flora of northern South America—VIII*

H. A. Gleason

ADDITIONAL NEW SPECIES OF MELASTOMATACEAE

Miconia subalpina n. sp. Arborescent; stems above obtusely 4-angled, prominently 4-sulcate, densely villous or subtomentose with spreading or somewhat reflexed simple hairs about 1 mm. long; petioles slender, 3.5–6 cm. long, pubescent like the stem, the hairs frequently stout and flattened; leaf-blades membranous, ovate, 12 cm. long, 8–9 cm. wide, acute, irregularly serrulate, ciliate, broadly rounded at base, upper surface plane, dark green, sparsely pilose in the vein-areas with slender yellowish hairs 0.5–1 mm. long, lower surface pale green, minutely punctulate, pilose along the veins and veinlets with slender, somewhat crooked, whitish hairs mostly 0.5–0.7 mm. long, 7-pli-nerved, the veins and veinlets obscure above, prominulous beneath; panicles small, few-flowered, 10 cm. long, including the peduncle, densely pubescent like the stem; pedicels 3–5 mm. long; flowers 5-merous; hypanthium broadly campanulate, 6 mm. in length and diameter, densely hirsute with spreading or somewhat reflexed hairs about 1.2 mm. long; calyx-tube prolonged 1 mm. beyond the staminal torus, hirsute like the hypanthium; sepals broadly triangular, 4.5 mm. wide, 1.8 mm. long, subacute, the free margin scarious, glabrous, and densely ciliate with stout hairs 0.5–0.7 mm. long, exterior teeth stout, appressed, about equaling the sepals, 1.5 mm. long, 0.5 mm. thick, hirsute like the hypanthium; petals white, recurved, broadly obovate, 8 mm. wide, 6.5 mm. long, from a truncate base 2 mm. wide, broadly rounded and somewhat retuse at the apex, many-nerved; anthers stout and thick, 3 mm. long, 1.7 mm. thick (radially), 1.2 mm. wide (tangentially), blunt, opening by a single terminal pore 0.4 mm. wide, the connective much thickened below and minutely saccate at base; filaments flat, 3.7 mm. long, 1.7 mm. wide at base, tapering gradually to 0.8 mm. wide at the summit, glabrous; ovary concave at the summit, glabrous; style straight, 9 mm. long, 0.7 mm. in diameter, glabrous; stigma broadly capitate or subpeltate, 0.7 mm. long, 1.7 mm. in diameter.

Type, *Pennell 10,504*, collected in mossy forest, Cerro Tatama, Dept. Caldas, Colombia, alt. 3200–3400 m., 8–10 Sept. 1922, and deposited in the herbarium of the New York Botanical Garden. But few species of the section *Amblyarrhena* have such large flowers, and they mostly have glandular styles and

* Contributions from the New York Botanical Garden, no. 277.

filaments. In some superficial characters of foliage it resembles *M. psychrophila*, but I know of no species to which it appears definitely related. Under the arrangement of species in Cogniaux's monograph, it falls in the group 362 to 381.

Miconia aggregata n. sp. Arborescent; stems obscurely 4-angled, densely pilose or subtomentose with brown, spreading or somewhat reflexed hairs 1.5 mm. long; petioles stout, 25–35 mm. long, pilose like the stem; leaf-blades firm, ovate, 15–20 cm. long, 8–10.5 cm. wide, obliquely long-acuminate, finely serrulate, broadly rounded at base, upper surface dull green, densely strigose with brown, curved-ascending hairs 1 mm. long, lower surface cinereous, softly subtomentose with spreading, somewhat crooked hairs 1–1.5 mm. long, 5-pli-nerved, the veinlets 3–5 mm. apart; panicles pyramidal, 9 cm. long, the rhachis and branches pubescent like the stem; bracts subulate, 2 mm. long; flowers 5-merous, sessile, in dense, globose, terminal glomerules; hypanthium cylindric, 3.7 mm. long, densely pilose with spreading hairs 1 mm. long; sepals membranous, broadly triangular, 0.4–0.5 mm. long, the free portion glabrous, exterior teeth broadly conic, 0.2 mm. long; petals depressed-ovate, 1.2 mm. long, 1.7 mm. wide; filaments stout, flat, 2.2 mm. long; anthers oblong-elliptic, 1.5 mm. long, obtuse, thicker than wide, unappendaged, opening by a minute terminal pore; ovary glabrous at the summit; style straight, terete, 3.3 mm. long, hirtellous; stigma peltate, 1 mm. in diameter.

Type, *Rusby & Pennell 813*, collected in the forest at "Balsillas," on Rio Balsillas, Dept. Huila, Colombia, alt. 2100–2200 m., 3–5 Aug. 1917, and deposited in the herbarium of the New York Botanical Garden. The species is closely related to *M. capitellata* Cogn., in which the leaves are merely obtuse at base, the pubescence throughout much shorter, the hypanthium smaller, the ovary setulose at the apex, and the style glandular-hirtellous.

Miconia Pennellii n. sp. Fruticose or arborescent; stems somewhat flattened or obscurely 4-angled, roughly strigose with short brown hairs; petioles stout, strigose like the stem, 3–4 cm. long; leaf-blades membranous, narrowly ovate to ovate-oblong, 13–18 cm. long, 7–9 cm. wide, acuminate, conspicuously serrulate, rounded at base, upper surface dull green, scabrously strigose with short hairs from a conic base, lower surface ferruginous, foveolate, roughly pubescent with short, crisped or crooked hairs, particularly on the veins, 7-nerved, the outer pair obscure, veinlets 4–5 mm. apart, the tertiary veinlets prominulous beneath; panicles small, congested, 10–15 cm. long, the rhachis

and branches densely strigose-hispid; bractlets minute, oblong, acuminate, ciliate; flowers sessile, 5-merous; hypanthium campanulate-cylindric, 4 mm. long, densely strigose with stout, ascending hairs about 0.5 mm. long; sepals membranous, broadly triangular-ovate, 1.5 mm. long, rounded at the apex, the exterior teeth stout, conic, 1 mm. long, spreading or somewhat recurved, strigose like the hypanthium; petals broadly obovate, 2.7 mm. long, glabrous; filaments stout, flat, 2.5 mm. long, 0.8 mm. wide, minutely and sparsely hirtellous; anthers stout, oblong, 1.6 mm. long, opening by a small terminal pore, unappendaged; ovary setulose at the tip; style stout, 3.3 mm. long, 0.8 mm. in diameter, tapering slightly upward, hirtellous, not glandular; stigma peltate, 1 mm. in diameter.

Type, *Killip 7951*, collected in the forest at "La Gallera," Micay Valley, Dept. El Cauca, Colombia, alt. 2000–2200 m., 1 July 1922, and deposited in the herbarium of the New York Botanical Garden. The type is in flower; the fruiting condition is represented by *Pennell 7577*, from "San Jose," San Antonio, Dept. El Cauca, 2400–2700 m., 1 July 1922. Of the section *Amblyarrhena*, it resembles *M. capitellata* in habit, but in that species the leaves are 7-pli-nerved and the pubescence of the stem is spreading. *Lehmann 5921* and *8519* are cospecific.

Miconia penicillata n. sp. Shrubby, 5 dm. tall; stems nearly terete, persistently and densely stellate-tomentose and sparsely pilose with spreading hairs 1.5 mm. long, bearing a tuft of slender apical branches; petioles slender, 2–3 cm. long, pubescent like the stem; leaf-blades firm, ovate-oblong, 8–10 cm. long, 4–5 cm. wide, sharply and abruptly acuminate, finely serrulate, broadly acute at base, upper surface dark green, bullate-strigose with short stiff hairs, lower surface ferruginous, foveolate, thinly but closely stellate-tomentose and sparsely pilose on the principal veins, 7-pli-nerved, the veinlets prominently elevated beneath; panicle widely spreading, freely branched, on a long peduncle, the rhachis and branches pubescent like the stem; bracts obovate, 2–3 mm. long, stellate-tomentose; flowers 5-merous, sessile, crowded in dense terminal and subterminal glomerules; hypanthium obconic, 3 mm. long, densely brown stellate-tomentose; sepals broadly ovate, 0.6 mm. long, 1.1 mm. wide, the margin scarious, the exterior teeth minute, conic; petals white, elliptic-obovate, 2.3 mm. long, 1.6 mm. wide, glabrous, entire; filaments 2.6 mm. long, glabrous, the lower three-fourths flat, 0.4 mm. wide, the upper one-fourth slender; anthers oblong, blunt, thick, 1.4 mm. long, broadest (0.6 mm.) near the apex, opening by a small terminal pore, the connective thick, not prolonged or appendaged; ovary glabrous at the

summit; style straight, terete, 3.3 mm. long, gradually thickened upward, glabrous; stigma capitate, 0.8 mm. in diameter.

Type, *Pennell & Killip 5808*, collected in forest, on a peak southeast of La Cumbre, Dept. El Valle, Colombia, alt. 2150–2400 m., 14–19 May 1922, and deposited in the herbarium of the New York Botanical Garden. The species is a member of the section *Amblyarrhena* and related to *M. capitellata* Cogn. It differs from that and allied species in the conspicuous stellate tomentum on the stem, lower leaf-surface, inflorescence, and hypanthium, coupled with the prominent, long, penicillate hairs on the stem and panicle.

Miconia minuta n. sp. Fruticose; stems obscurely 4-angled and lightly 4-sulcate, sparsely stellate-furfuraceous, glabrescent with age; petioles slender, 2 cm. long, channeled above, minutely furfuraceous; leaf-blades membranous, oblong-elliptic, 18 cm. long, 7–8 cm. wide, sharply acuminate, entire, conspicuously but finely ciliate (about 16 cilia per cm. of margin, 0.5 mm. long), cuneate at base, dark green and glabrous above, or sparsely furfuraceous along the midvein, pale green, glabrous on the surface, and minutely and sparsely furfuraceous on the veins beneath, 7-nerved, the outer pair of veins 0.5 mm. from the margin, the next pair 2 mm. from the margin, veinlets strongly ascending, 3–4 mm. apart; panicle freely branched, 11 cm. long, the rhachis and branches conspicuously stellate-furfuraceous and also pilose with spreading hairs 0.7 mm. long; pedicels glabrous, 0.5 mm. long; flowers 5-merous; hypanthium broadly campanulate, 1.2 mm. long by 1.3 mm. wide, glabrous; sepals depressed-triangular, 0.2 mm. long, 0.5 mm. wide, subacute, glabrous, the exterior teeth triangular, acute, less than 0.1 mm. long; petals oblong-obovate, white, 0.8 mm. long, 0.5 mm. wide, rounded at the apex; filaments 1 mm. long, glabrous, the lower three-fifths stout, the upper two-fifths slender; anthers oblong, 0.6 mm. long, broadest near the summit, 0.2 mm. wide, somewhat attenuate at base, the anther-sacs minutely gibbous at the base anteriorly, opening by two wide terminal pores; ovary rounded at the summit, glabrous, radially ribbed; style straight, stout, terete, 0.7 mm. long, 0.2 mm. in diameter; stigma capitate, 0.3 mm. in diameter.

Type, *Rusby & Pennell 791*, collected in forest at "Balsillas," on the Rio Balsillas, Dept. Huila, Colombia, alt. 2100–2200 m., 3–5 Aug. 1917, and deposited in the herbarium of the New York Botanical Garden. It finds its nearest relative apparently in *M. Lehmannii* Cogn., from which it differs in its ciliate leaves, its pilose inflorescence, and its short style. Its flowers are smaller than those of any other species of *Miconia* known to me.

Miconia mimica n. sp. Arborescent; stems prominently 4-sulcate with rounded ribs, glabrous, or furfuraceous-annulate at the nodes above; petioles stout, 25–40 mm. long, glabrous below, conspicuously furfuraceous on the upper side at the summit; leaf-blades thin and membranous, elliptic-obovate, the members of each pair somewhat unequal, 12–17 cm. long, 6–8.5 cm. wide, abruptly and sharply acuminate, minutely denticulate with ascending or appressed teeth (about 8 teeth per cm. of margin, 0.3 mm. long), obtuse to subrotund at base, dark green and glabrous above, pale green and glabrous beneath, 5-nerved, the outer pair obscure and submarginal, the middle three lightly impressed above, prominent beneath, veinlets conspicuous, especially beneath, tertiary veinlets conspicuously reticulate; panicle freely branched, spreading, 12 cm. long, glabrous or sparsely furfuraceous at the nodes; bractlets none or caducous; pedicels 0.3–0.8 mm. long; flowers 5-merous; hypanthium subturceolate, 1.4 mm. long, 1.3 mm. in diameter, brown, glabrous; sepals broadly rounded, 0.7 mm. wide, 0.2 mm. long, glabrous, the free margin scarious, exterior teeth broadly triangular, appressed, obtuse, less than 0.1 mm. long; petals broadly obovate, pale yellow, 0.8 mm. long, 0.7 mm. wide, glabrous; filaments glabrous, 1 mm. long, the lower three-fifths stout, the upper two-fifths slender; anthers oblong-obovate, 0.8 mm. long, the anther-sacs 0.5 mm. long, 0.3 mm. wide, opening by a double terminal pore of the same width, connective thickened on the back and prolonged 0.3 mm. below the anther-sacs, minutely bigibbous anteriorly; ovary rounded at the summit, glabrous, strongly radially ribbed; style straight, terete, glabrous, 2 mm. long, 0.3 mm. in diameter; stigma peltate, 0.6 mm. in diameter.

Type, *Killip 7936*, collected in forest at "La Gallera," Micay Valley, Dept. El Cauca, Colombia, alt. 1900–2000 m., 1 July 1922, and deposited in the herbarium of the New York Botanical Garden. It is a member of the section *Cremanium*, and bears a strong resemblance to *M. minuta* Gleason in its general appearance and small flowers. It differs in its nonciliate leaves, its nearly glabrous inflorescence, its broader exterior calyx-teeth, its longer style and the conspicuously prolonged connective. It also closely resembles *M. coelestis* (Pav.) Naud., a plant of Peru and Bolivia with sessile flowers.

Miconia cuneifolia n. sp. Low tree; stems obtusely 4-angled and densely and closely ferruginous-tomentulose when young, becoming terete and glabrous with age; petioles slender, 12–15 mm. long, nearly terete, thinly tomentulose; leaf-blades firm, oblong-obovate, 7–10 cm. long, 22–35 mm. wide, sharply acuminate, entire, slightly revolute, cuneate from above the

middle to the base, upper surface dark green, slightly rugose, glabrous, lower surface closely ferruginous-tomentose with stellate hairs, 5-nerved, the veinlets 1.5–2 mm. apart; panicles 8 cm. long, the rhachis and branches densely ferruginous-tomentose; flowers 6-merous, sessile, closely crowded in terminal and subterminal glomerules; hypanthium campanulate, 2.3 mm. long, densely but closely stellate-tomentulose; sepals broadly triangular, 0.4 mm. long, subacute, pubescent like the hypanthium, the exterior teeth apparently none; petals rotund-spatulate, 1.5 mm. long, 1.1 mm. wide, glabrous; anthers obovate-oblong, 1.7 mm. long, 0.7 mm. wide, opening by two broad terminal pores, somewhat attenuate to the base and minutely 2-gibbous, connective thickened below and minutely saccate at the base posteriorly; filaments 3–4 mm. long, glabrous, bent at three-fourths of their length, the basal portion stout, somewhat flattened, 0.3 mm. wide, the distal portion slender; ovary broadly ovoid-conic at the summit, glabrous, radially ribbed; style straight, 3.3–4 mm. long, terete, glabrous; stigma capitate, 0.6 mm. in diameter.

Type, *Rusby & Pennell 831*, collected at edge of a bog, "Balsillas," on the Rio Balsillas, Dept. Huila, Colombia, alt. 2100–2200 m., 3–5 Aug. 1917, and deposited in the herbarium of the New York Botanical Garden. It is a member of the section *Cremanium* and related to species 429–431 of Cogniaux's monograph, but differing from any of them in the long, cuneate leaf-base.

Miconia turgida n. sp. Arborescent; stems stout, 4-angled, lightly 4-sulcate, and thinly furfuraceous above, becoming terete and glabrous in age; petioles stout, 4–5 cm. long, channeled above, flattened toward the summit, thinly furfuraceous; leaf-blades thick, elliptic, 23 cm. long, 10.5 cm. wide, abruptly acuminate to a short obtuse apex, remotely spinulose-denticulate (2–3 teeth per cm. of margin, 0.4 mm. long), acute at base, yellow-green and glabrous above, with deeply impressed veins, brownish-green, minutely punctate on the surface, and sparsely furfuraceous on the veins beneath, 5-nerved, the veins prominent beneath, the outer pair submarginal, the veinlets ascending, 3–4 mm. apart, the tertiary veinlets reticulate; panicle sessile, 10 cm. long, the rhachis and branches 4-angled, thinly furfuraceous, especially at the nodes; flowers 5-merous, on pedicels 1 mm. long; hypanthium campanulate, 2.7 mm. long, 3.1 mm. in diameter, glabrous, minutely punctate; sepals broadly ovate, 0.6–0.8 mm. long, glabrous, truncate or rounded, the margin membranous, exterior teeth flattened, conic, appressed, 0.5 mm. long, blunt, minutely puberulent; petals broadly obcordate from a truncate base, 1.7 mm. long and wide, white,

glabrous; filaments 2.7 mm. long, 0.6 mm. wide at base, gradually narrowed to 0.3 mm. at the summit, the lower three-fifths strongly turgid; anthers obovate, 1.9 mm. long, 0.9 mm. wide, the two terminal pores together 0.5 mm. wide, attenuate and bigibbous at base, the connective strongly thickened and prolonged posteriorly into a blunt appendage 0.3 mm. long; ovary hemispheric at the summit, glabrous, with 10 rounded radial ribs not elevated around the style; style straight, terete, 3.3 mm. long, 0.4 mm. in diameter, glabrous; stigma capitate, 0.8 mm. in diameter. FIG. 1.

Type, *Pennell 9302*, collected in forest at "Pinares," above Salento, Dept. Caldas, Colombia, alt. 2600–2800 m., 2–10 Aug. 1922, and deposited in the herbarium of the New York Botanical Garden. The type specimen exhibits a pair of leaves of the dimensions indicated on the old wood near the base, and a young flowering branch from the base of a fruiting panicle.

FIG. 1. MICONIA TURGIDA Gleason, stamens × 7.5.
FIG. 2. KILLIPIA QUADRANGULARIS Gleason, portion of inflorescence, natural size.

On the latter the leaves are smaller, and the members of each pair unequal in size, varying from 65 by 23 mm. to 90 by 40 mm. for the smaller, and from 120 by 48 mm. to 150 by 62 mm. for the larger, the smaller pairs being the uppermost. In these the petioles range from 10 to 16 mm. long. The fruit is globose, 6 mm. in diameter. The plant bears a superficial resemblance to *M. scutata* Gleason, but belongs to the section *Chaenopleura*. Under the artificial disposition of the species in Cogniaux's monograph, it stands near species 494 to 498, and differs from them in the leaves acute at base and in numerous details of structure.

Miconia Cladonia n. sp. Tall shrub or low tree; stems nearly terete, sparsely furfuraceous when young with freely branched hairs nearly 1 mm. long, glabrescent and verrucose in age; petioles stout, 6–10 mm. long, pubescent like the stem;

leaf-blades broadly elliptic to obovate-oblong, or rarely oblong-ovate, thick and firm, 4.5–7 cm. long, 23–36 mm. wide, abruptly subacuminate, spinulose-denticulate with appressed teeth (4 or 5 teeth per cm. of margin, nearly 1 mm. long), broadly acute at base, dark yellowish-green and glabrous above, pale yellow-green and minutely punctate on the surface beneath and conspicuously tomentose along the veins with freely branched hairs about 0.5 mm. long, 3-nerved, the veins lightly impressed above, elevated beneath, the veinlets obscure above, barely prominulous beneath, the tertiary veinlets invisible; panicles sessile, congested, 4 cm. long, the rhachis and branches 4-angled, pubescent like the stem; pedicels 0.7 mm. long, minutely pubescent, or many flowers sessile; bracts elliptic, 4 mm. long, 1.6 mm. wide, brown, acute, densely ciliate; flowers 5-merous; hypanthium obconic-campanulate, yellowish-green, 2.1 mm. long, minutely punctulate; sepals semicircular, 0.6 mm. long, 1.3 mm. wide, the free margin scarious, somewhat erose-denticulate, exterior teeth triangular, as wide as the sepals, 0.3 mm. long, minutely and acutely apiculate; petals white, obovate-rotund, 2.5 mm. long, 2 mm. wide; filaments 2.6 mm. long, 0.5 mm. wide at the base, gradually attenuate to 0.2 mm. wide at the apex, slightly bent at three-fifths of their length, the lower portion somewhat turgid, the upper nearly terete; anthers 1.2 mm. long, obovate, opening by a triangular notch 0.5 mm. wide by a third as deep, the anther-sacs minutely prolonged at base, connective strongly thickened on the back, prolonged into an ovoid spur 0.2 mm. long at the base posteriorly; ovary glabrous at the summit, ovoid, prominently elevated around the style; style straight, terete, glabrous, 3 mm. long; stigma capitate, 0.7 mm. in diameter.

Type, *Pennell 7544*, collected in the shrub zone ("paramillo") on Mount El Trueno, Dept. El Cauca, Colombia, alt. 2700–3000 m., 29, 30 June 1922, and deposited in the herbarium of the New York Botanical Garden. Other specimens, agreeing with the type in every respect except minor details of dimensions, and all from El Cauca, are *Pennell 7529*, same locality, altitude, and date, *Pennell 7498*, shrub zone on Mount El Derrumbo, alt. 2700–3000 m., 29 June, 1922, and *Pennell & Killip 7434*, bushy forest, "San Jose," San Antonio, alt. 2400–2700 m., 28 June, 1922. The characteristic features of the plant are its yellowish-green foliage and the prominent zones of branched hairs along the veins. Under the lens these hairs resemble the reindeer moss, and have suggested the specific name. It is a member of the section *Chaenopleura*, and closely related to *M. flavescens* Cogn., of Bolivia. In the latter the leaves are rounded

or subcordate at base, somewhat 3-pli-nerved, and closely furfuraceous along the veins; the stem is densely brown-furfuraceous when young, the bracts are none or caducous, and the flowers are on pedicels 1–3 mm. long.

Clidemia cymosa n. sp. Stem shrubby, apparently erect, terete, hirsute or subhispid with straight, spreading hairs 1.5–2 mm. long, and also short-pubescent around the nodes; petioles stout, 5 mm. long or less, densely hirsute with spreading hairs 2.5 mm. long and also puberulent; leaf-blades membranous, broadly round-ovate, abruptly acuminate, conspicuously and irregularly dentate (4–6 teeth per cm. of margin, 0.5–2 mm. high), cordate at base, 7-nerved, the larger with an obscure additional pair, upper surface plane, sparsely hirsute with straight hairs 1–1.5 mm. long and also minutely puberulent when young, lower surface hirsute, especially on the veins, with white hairs mostly 0.7 mm. long; cymes axillary, freely branched, lax and open, 20 cm. long, 15 cm. wide, hirsute like the stem, the ultimate branches bearing mostly 2 flowers on pedicels 4–5 mm. long; flowers 4-merous, bracted by several stout setae 3–4 mm. long; hypanthium narrowly obovoid-oblong, 5 mm. long, sparsely setose and closely and minutely tomentulose; sepals membranous, depressed-ovate or nearly semi-circular, 0.7 mm. long, tomentulose, the exterior teeth stout, spreading, conic, 1.3 mm. long, setose, tomentulose; petals apparently white, obovate-oblong, 2.3 mm. long, 1.7 mm. wide, rounded at the apex, glabrous; stamens 8; filaments stout, flattened, 2.4 mm. long, 0.7 mm. wide; anthers linear, 3.5 mm. long, tapering to the apex, unappendaged; ovary truncate, glabrous, 4-locular; style stout, terete, 5.5 mm. long; stigma capitate.

Type, *Pennell 1510*, collected on a moist bank, Villavicencio, Intendencia Meta, Colombia, alt. 500 m., 26–31 Aug. 1917, and deposited in the herbarium of the New York Botanical Garden. The leaves vary in size in each pair. The largest leaf, the opposite of which is missing, measures 20 cm. long by 15.5 cm. wide; a second pair measures 19 by 11.5 and 12 by 7.5, and another set is 10 by 6 and 7 by 5 cm. The collector noted that the fruit was fleshy and purple. *C. cymosa* is most closely related to *C. impetiolaris* Cogn. and *C. ciliata* D. Don, notwithstanding the fact that a difference in the number of leaf-nerves led Cogniaux to place these two species a few pages apart in his monograph. Our species is distinguished by the setose or hirsute pubescence, the almost entire absence of stellate pubescence, the larger leaves and cymes, and the shorter external teeth of the calyx.

Killipia n. gen.

Flowers 5-merous, pedicelled, in axillary bracted cymes fascicled in the axils; hypanthium broadly campanulate; sepals erect, with small exterior teeth; petals yellow, broadly ovate, obtuse, incurved at the summit; stamens all alike; anthers oblong, truncate, opening by a large terminal pore, minutely tuberculate at base; connective slender, not prolonged at base, with two minute, ovoid, saccate appendages on the dorsal side; filaments articulated directly to the anthers, curved, thickened below, tapering to the summit; ovary inferior, its summit depressed conic, glabrous; style straight, stout; stigma punctiform.

Killipia quadrangularis n. sp. Arborescent; the branches stout, glabrous, acutely quadrangular or narrowly 4-alate, the internodes 10–15 mm. long when young, lengthening in age to 25 mm.; leaves opposite, the members of each pair essentially equal; leaf-blades stiff, thick, narrowly elliptic-oblong, 9–13 cm. long, 20–28 mm. wide, strongly ascending, acute, subrevolute, minutely setulose-serrulate with appressed teeth (about 3–8 teeth per cm. of margin, 0.1–0.2 mm. long), gradually narrowed below to a short, stout, flat, winged petiole 8–10 mm. long by 2–3 mm. wide, strongly 3-nerved, with an additional obscure intramarginal pair, upper surface dull yellowish-green, glabrous, rugose with strongly impressed veins and lightly impressed, crooked, reticulate veinlets, lower surface red, the strongly elevated veins and reticulate plane veinlets black, glabrous, the petiole and nodes thinly furfuraceous; cymes 3–5 in each axil, about 2 cm. long, 3-flowered, bearing two bracts at the base of the lateral pedicels and two below each flower; bracts red, linear-elliptic, 5–7 mm. long, 0.8–1 mm. wide, narrowed to both ends, sparsely setulose-ciliate; pedicels red, 5 mm. long, jointed at the middle; hypanthium reddish, broadly campanulate, 2.1 mm. in diameter, 1.8 mm. long, obscurely ribbed, glabrous; sepals ovate, 1.6 mm. long, 1.2 mm. wide, broadly rounded or truncate at the apex, glabrous, the exterior teeth stout, closely appressed, triangular, acute, 1 mm. long, 0.6 mm. wide; petals yellow, broadly ovate, 5 mm. long, 3 mm. wide, membranous, rounded at the apex, glabrous; stamens 10; anthers 2-celled, oblong, slightly broadened distally to the truncate apex, 1.2 mm. long, 0.4 mm. wide, minutely tuberculate at base, the appendages of the connective 0.2 mm. long; filaments sigmoid, 1.5 mm. long, 0.4 mm. wide below, tapering to a terete summit 0.15 mm. in diameter; ovary half as long as the hypanthium, its summit obscurely 10-ribbed; style terete, 2.5 mm. long, 0.35 mm. in diameter, glabrous; stigma punctiform; fruit unknown. FIG. 2, page 453.

Type, *Killip 8007*, collected in the forest at "La Gallera,"

Micay Valley, Dept. El Cauca, Colombia, alt. 2200–2600 m., and deposited in the herbarium of the New York Botanical Garden.

Notwithstanding the lack of mature fruit or seeds, *Killipia* is obviously a member of the tribe Miconieae, as shown by the structure of the stamens, the inferior ovary, the presence of exterior calyx-teeth, and the lateral cymules. It is distinguished from *Ossaea*, *Henriettella*, and *Myriaspora* by its obtuse petals; from *Loreya* by its differentiated sepals; from *Henriettea* by its truncate anthers; from *Microphysca* by its wingless hypanthium and absence of formicaria; from *Myrmedone*, by its 5-merous flowers; from *Maieta* by its quadrangular branches; from *Bellucia* by its small flowers and external calyx-teeth; from *Mecranium* by the absence of a prolonged connective; and from *Clidemia* by its stout anthers and glabrous flowers and foliage.

Ossaea grandifolia n. sp. Section Octopleura; probably arborescent; branches stout, brown, terete or nearly so, glabrate; leaves firm, oblong-obovate, 30–35 cm. long, 12–15 cm. wide, attenuate at base along the stout petiole almost to its base, entire, rounded at the apex, glabrous above, minutely puberulent along the midvein beneath, distinctly 5-pli-nerved, the lateral veins arising about 25 and 40 mm. from the base, veinlets conspicuous, 6–7 mm. apart; panicles 10 cm. long, densely furfuraceous, the branches spreading; flowers sessile, 4-merous; fruiting hypanthium depressed-globose, strongly 8-ribbed, minutely stellate-puberulent, 2 mm. long.

Type, *Killip 5120*, collected in forest at Cordoba, Dept. El Valle, Colombia, alt. 80–100 m., 6, 8 May 1922, and deposited in the herbarium of the New York Botanical Garden. Although the specimen unfortunately bears no flowers, and notwithstanding the fact the the single panicle appears to be terminal, I have placed this interesting plant in the genus *Ossaea*, because of its strongly ribbed fruit and general resemblance to *O. diversifolia*. It differs from this species in its glabrous foliage and 4-merous flowers.

Blakea fasciculata n. sp. Fruticose; flowering axes subterete, minutely and closely furfuraceous, the internodes 10 cm. long; petioles stout, 6 cm. long, finely striate, sparsely and minutely furfuraceous; leaf-blades broadly elliptic to elliptic-obovate, membranous, 15–18 cm. long, 8–10.5 cm. wide, rounded above to a triangular cusp 5 mm. long, minutely denticulate (teeth salient, blunt, 0.2 mm. high, 3 or 4 per cm. of margin), rounded

or barely subcordate at base, 7-nerved, the veinlets somewhat ascending, 2.5–3 mm. apart, glabrous on the surface, minutely furfuraceous on the veins and on the veinlets beneath; flowers 6-merous, in crowded axillary fascicles, on 4-angled, minutely furfuraceous pedicels 1–2 cm. long; bracts 4, separate, closely surrounding the calyx in bud, somewhat surpassing the sepals in anthesis, obovate, obtuse or subacute, narrowed to the base, minutely furfuraceous, obscurely nerved; hypanthium broadly campanulate, 5 mm. long, glabrous, 12-ribbed within between the ovary and the staminal torus; sepals firm or coriaceous, brown, ovate-triangular, 3.5 mm. long and wide, obtuse, glabrous; petals pink, 12 mm. long, minutely ciliolate, otherwise glabrous, longitudinally nerved; stamens all alike, strongly inflexed; anthers connivent, stout and thick, oblong-elliptic, 5 mm. long, 2.5 mm. wide, laterally flattened, rounded at the summit, opening by minute terminal pores; connective thick, not prolonged below the anthers, the posterior spur stout, conic, 1.5 mm. long, wrinkled, apiculate, channeled on the anterior side; filaments flat, 5 mm. long, 1.3 mm. wide, tapering slightly to the summit; ovary inferior, the summit conic around the depressed center, sharply 12-ribbed, each rib ending in a minute erect free lobe; style terete, straight, 12 mm. long; stigma punctiform.

Type, *Pennell 4466*, collected in forest at Antizales, Dept. Bolivar, Colombia, alt. 1200–1600 m., 25, 26 Feb. 1918, and deposited in the herbarium of the New York Botanical Garden. Apparently related to *B. latifolia* (R. & P.) D. Don, but differing in its larger leaves and calyx and in its leaves rounded at base.

Blakea brachyura n. sp. Arborescent; branches terete or nearly so, glabrous; petioles stout, 10–15 mm. long, glabrous or verrucose; leaf-blades dull green, thick and firm, broadly elliptic, the largest 77 mm. long by 45 mm. wide, abruptly acuminate into an apical cusp 5–7 mm. long, entire, obtuse at base, 5-nerved, the veinlets obscure, 0.3–0.5 mm. apart, glabrous on both sides, minutely and densely punctate above; flowers 6-merous, solitary or paired in the upper axils, on somewhat verrucose pedicels 20–35 mm. long; bracts 4, broadly rounded, coriaceous, or chartaceous at the margin, glabrous, the outer pair somewhat connate at base, 4 mm. long, the inner pair 5 mm. long; hypanthium coriaceous, broadly campanulate, 6 mm. long, the sepals obsolete; petals white, 9 mm. long, abruptly widened at the middle from a darker base to a membranous acute tip 7 mm. wide; anthers narrowly oblong, 4.5 mm. long, opening by 2 terminal pores, the stout connective prolonged at the base posteriorly into a subulate spur 0.7 mm. long; filaments stout, narrowly elliptic-oblong, 3 mm. long, 0.7 mm. wide.

Type, *Pennell 10,742*, from the edge of the forest at "Buenos Aires," north of Supia, Dept. Caldas, Colombia, alt. 2000–2200 m., 18, 19 Sept. 1922, and deposited in the herbarium of the New York Botanical Garden. It is related to *Blakea rostrata* O. Berg, a Peruvian species with more caudate leaves, shorter pedicels, and more pubescent pedicels and bracts.

Blakea quadriflora n. sp. Glabrous throughout; stems woody, subterete, or somewhat flattened below the nodes; petioles 3 cm. long, strongly channeled above; leaf-blades membranous, bright green, broadly elliptic or slightly obovate, 16 cm. long, 10.5 cm. wide, rounded to an abruptly cuneate base, entire, rounded above to a triangular apex 3–5 mm. long, 5-nerved, the nervules mostly 2 mm. apart; flowers 6-merous, in opposite axillary fascicles of 4; pedicels strongly flattened, somewhat broadened upwards, 25–35 mm. long; bracts 4, free, pale green, broadly obovate from a cuneate base, rounded or minutely apiculate at the apex, both outer and inner about 1 cm. long; hypanthium short-cylindric or broadly campanulate, 6 mm. long and the same in diameter; sepals reduced to callous teeth 0.3 mm. long; petals white, broadly rotund, 5.5 mm. long; anthers coherent in a ring, broadly oblong, 3 mm. long, with a minute basal protuberance; filaments as broad as the anthers, 2 mm. long; style narrowly conic, 5 mm. long.

Type, *Hitchcock 21,160*, collected between La Chorita and Portovelo (Gold Mine near Zaruma), Prov. Oro, Ecuador, alt. 1000–2000 m., 28 Aug. 1923, and deposited in the herbarium of the New York Botanical Garden. Related to species 8 to 13 in Cogniaux's monograph, of which only *B. latifolia* (R. & P.) D. Don and *B. podagrica* Triana are glabrous: of these two the former has solitary flowers and the latter long-acuminate bracts.

Topobea alternifolia n. sp. Probably arborescent; branches slender, terete or nearly so, the leafy twigs conspicuously zigzag, thinly but closely furfuraceous-tomentulose when young, becoming glabrate with age, the upper internodes about 1 cm. long; leaves alternate; petioles slender, channelled above, minutely furfuraceous on the back, 7–10 mm. long; leaf-blades thin, oblong-elliptic to oblong-obovate, abruptly acuminate into a linear-caudate apex, entire, cuneate at base, glabrous and shining on both sides, 5-pli-nerved, the veinlets conspicuous, about 1 mm. apart; flowers 6-merous, axillary, solitary, on strongly furfuraceous pedicels 20–25 mm. long; hypanthium globose, furfuraceous, 3 mm. long, much exceeding the 4 minute, broadly rounded, furfuraceous bracts; calyx prolonged about 1 mm. beyond the hypanthium, the sepals triangular, thinly furfuraceous, 1.5 mm. long.

Type, *Killip 5125*, collected in the forest at Cordoba, Dept. El Valle, Colombia, alt. 80–100 m., 6, 8 May 1922, and deposited in the herbarium of the New York Botanical Garden. The leaf-blade is 25–35 mm. wide by 60–90 mm. long, of which 10–20 mm. is included in the conspicuous linear tip. The pedicels arise not only from the axils of the developed leaves, but also opposite them, in the axil of the abortive leaf. *T. alternifolia* is related to the last three species of Cogniaux's monograph, all of which have leaves rounded or cordate at the base and the smaller leaf of each pair present, as well as differing in other details.

A critical consideration of Hagström's work on Potamogeton[1]

HAROLD ST. JOHN

(WITH A TEXT FIGURE)

In the Swedish periodical cited below[2] the late Dr. J. O. Hagström published a monograph of the genus *Potamogeton*. This is by no means the first, for during the last thirty-one years there have been five such general treatments, by Morong, Fryer, Fischer, Ascherson and Graebner, and Taylor.

At least one copy of Hagström's work must have reached the United States soon after its publication in 1916. In the Botanical Gazette a short review or notice by J. M. C. [oulter] was printed in 1917.[3] The blockade of the North Sea, however, cut off the importations, and none of the libraries available to the writer in Boston were able to obtain a copy at that time. In 1918 and 1919, when in Paris, the writer renewed efforts to see Hagström's publication, but no copies were available there. Not until 1922 was his attempt to purchase a copy successful. A review of this paper was published in 1919 by the English specialist Arthur Bennett,[4] but it includes almost entirely different material from that presented here.

The object in reviewing Hagström's "Critical Researches" is to point out its resemblances and divergencies from previous monographs, and particularly to scrutinize the treatment of the North American species.

Hagström's studies on *Potamogeton* began in 1891. He made collections in the field, and studied those available in the principal herbaria in Sweden, Norway, and Denmark. He seems to have had all the important literature on the genus available. Judging by the specimens cited, these herbaria contain abundant material from the Scandanavian countries, a moderate amount from England, Germany, and the rest of Europe, and only small

[1] Contribution from the Botany Department, State College of Washington, No. 1.

[2] Hagström, J. O. Critical Researches on the Potamogetons. Kungl. Svenska Vetenskapsakademiens Handlingar **55**[5]: 1–281. *f. 1–119.* 1 N 1916.

[3] Bot. Gaz. **64**: 87–88. 1917.

[4] Trans. Proc. Bot. Soc. Edinburgh **27**: 315–326. 1919.

collections from Africa, Asia, Australia, South America, and North America. The number of specimens from the latter area is small. The portions of this continent represented are principally New England, and to a lesser extent the North Atlantic states, the upper Mississippi valley, and Ontario. The collectors in most cases were Tuckerman, Robbins, Faxon, and Morong. In many cases the data are incomplete, the localities being simply *Nov. Angl.*, or *Nov. Ebor.*

In the introductory portion, Hagström gives a lengthy description of the morphology of the genus. The external morphology is well covered, as has been done by previous authors. The internal morphology of the plant in general, and of the leaf and stem in particular is treated at equal length. He describes the nature of the stem, and particularly as to its epidermal cells, its endodermis, and its stelar arrangement. He tells of the varying types found in this stele at the nodes, internodes, at different internodes on the same stem, and in stranded or floating stems of the same plant. Cross sections of the stem for systematic classification should be cut, he says, "at about the middle of the spike-bearing shoot."[5]

Hybridity in the pondweeds is then discussed. As hybrids are admittedly difficult to determine and demonstrate, Hagström states the criteria he used in their recognition. These are, briefly: more or less sterility; more or less deformity or abortion in the stamens and pistils, and especially imperfect pollen; occurrence but rarely and that within the known range of both parents; and all characters of the plant reproducing those of one or the other parent, or being intermediate between them.

The systematic enumeration follows, consisting of two subgenera, five sections, 26 subsections, 138 species, and a large number of hybrids. At this point the reader meets a serious difficulty. There is no key of any kind. In order to identify a *Potamogeton*, it is necessary to read every page of this work, and practically memorize them. By elimination it is often possible to go directly to the subsection including a particular plant, but even this is not always possible, for *P. pectinatus* and *P. filiformis* are put in different subsections, while *P. pusillus* and *P. panormitanus* are put in different series. No bibliography of books consulted is included.

[5] Hagström, *op. cit.* 8.

Under each species, the important synonomy is given. Then comes a description of the gross morphology including the parts usually employed in distinguishing the species. Next follows a description of the internal morphology, especially of the stem and leaves. In most cases the pollen is not described. In a few it is said to be globose and small, or large. No illustrations of the pollen grains are given. It is not stated whether species having large pollen grains show the same number of chromosomes as those with small pollen grains. As a matter of fact no statement of chromosome number is to be found. Hence a student trying to recognize hybrid plants, as does Hagström, by their pollen, would have to investigate for himself not only the few species suspected, but all of the species in the area to determine their characteristics. Illustrations are included for nearly all of the species. They are text figures from line drawings. These show the shape and veining of the leaves fairly well. For a monograph promulgating a classification based largely on stem anatomy, the illustrations of the stem cross-sections are not detailed enough. These represent the stem by its outline, the outline of the lacunae, and areas of cross-hatching to represent the fibro-vascular bundles. A statement of its range finishes each species. In most cases this is based only on specimens examined, so that many citations are given in northern Europe, a small number elsewhere, and in North America very few. For North America the range is often quoted from Morong, or Robinson and Fernald in Gray's New Manual, but occasionally stated only as North America. Several species widely distributed and long recognized as North American plants, are not listed from that continent.

The North American species of *Potamogeton* are recognized by Hagström largely as has been customary. Since it is such a laborious task to find out what he does do with a species, a summary will be given here. Species treated by Hagström as in current manuals or the most recent revisions: *Potamogeton alpinus*, *P. amplifolius*, *P. bupleuroides*, *P. confervoides*, *P. crispus*, *P. dimorphus*, *P. foliosus*, *P. Hillii*, *P. illinoensis*, *P. lucens*, *P. natans*, *P. Oakesianus*, *P. obtusifolius*, *P. perfoliatus*, *P. polygonifolius*, *P. praelongus*, *P. pulcher*, *P. pusillus*, *P. Richardsonii*, *P. Robbinsii*, *P. rutilus*, *P. strictifolius*, *P. Vaseyi*, and *P. zosterifolius*.

P. americanus, var. *novaeboracensis* is listed in the index as *P. novaeboracensis*, but the reviewer has been unable to find it in the text. *P. pectinatus* is not listed for North America, except as the var. *zosteraceus*, which is what he calls our *P. latifolius*. *P. interruptus* is called *P. pectinatus*, var. *diffusus*, f. *interruptus*, but is not recorded for North America. *P. acutifolius* is not credited to the United States, but the old specimen from Lancaster is not discussed. He argues that there are no differences but size between var. *niagarensis* and var. *californicus* of *P. foliosus* and that they should be fused. He records *P. filiformis*, f. *luxuriosus* from Riv. St. Mary, Michigan. This seems to be one of the specimens listed by the present writer in Rhodora **18:** 135. 1916 as var. *borealis*. Hagström maintains *P. filiformis*, var. *occidentalis*, although no new interpretation or new stations are given. On page 134 of the above cited article, the writer discounted the value of this variety. For *P. Friesii* the name *P. mucronatus* Schrader is adopted, as is done by Graebner in the Pflanzenreich. *P. panormitanus* is maintained as a species, instead of as a synonym of, or a subdivision of, *P. pusillus*. *P. Aschersonii*, a South American species is here recorded from Cuba, Sable Island, Nova Scotia, and from Newfoundland. For *P. epihydrus* the name *P. Nuttallii* is adopted. He argues that as Rafinesque described his plant as with "foliis . . . submersis subcordatis" this name must be rejected as not applicable. For *P. fluitans* of Europe he adopts the name *P. nodosus*, and makes *P. americanus* a synonym, but without discussion of the characters that have led Morong, Fryer, Taylor, Robinson and Fernald to treat it as a distinct American species. For *P. heterophyllus* he adopts the older Linnaean name *P. gramineus*, as is now done by Graebner and other Europeans, a procedure which has more recently been taken up by Americans, as Fernald, and House.

Hagström describes the following new plants from the United States and Canada.

P. vaginatus Turcz., var. canadensis Hagstr. n. var. This is the same plant described four months earlier by the present writer as *P. moniliformis* St. John, and later reduced to the synonomy of *P. vaginatus* Turcz.

P. pectinatus L., var. zosteraceus (Fries) Hagstr. n. comb.

P. lacunatus Hagstr. n. sp. This is a segregate of *P. pusillus* and is recorded from Anticosti to Massachusetts.

P. lacunatus Hagstr., f. Novae-Angliae Hagstr. n. f. A slender form of the preceding.

P. conjugens Hagstr. n. sp. This is a segregate of *P. hybridus* or *diversifolius*. It is recorded from New Jersey, Pennsylvania, and San Louis Potosi.

P. pulcher Tuckerm., f. amphibius Hagstr. n. f. A form without submersed leaves, found in Massachusetts, Rhode Island, and Delaware.

P. rotundatus Hagstr. n. sp. This has floating leaves and lanceolate submersed leaves. It is listed from Nebraska, New Mexico, California, and Chihuahua.

P. cayugensis (Wieg.) Hagstr. n. comb.

P. illinoensis Morong, f. rosulatus Hagstr. n. f. This plant from Florida has very short internodes.

P. illinoensis Morong, f. homophyllus Hagstr. n. f. This lacks floating leaves. It is recorded from Michigan, Texas, and Michoacan.

Reference has been made to Hagström's recognition of hybrid Potamogetons. Between the North American species, he recognizes 25 hybrids, 15 of these being described as new. In all cases where these hybrids have not also received a binomial name, he coins one. Furthermore, under a number of these hybrids he describes and names numerous subdivisions, varieties, and forms. For instance under *P. gramineus* × *perfoliatus* he describes 3 varieties and 27 forms, not all of which are American. A study of his description of these 25 hybrids reveals that in most cases he seems to have applied his various tests of hybridity. The pollen or most of it is stated to be imperfect, the pistils are more or less abortive, seldom setting fruit, the general characteristics of external and internal morphology mimic or are intermediate between those of the alleged parents, and the occurrence is stated within the ranges of parents.

Let us examine, however, the treatment of one species, *P. illinoensis* and its hybrids. It is by all American authorities agreed to be a good species, but a very local one, restricted to a part of the Mississippi valley in western Illinois, eastern Iowa, and Minnesota. Hagström corroborates this range, but describes two new forms, as noted in the list above, which extend the range very considerably, as they occur in Michigan, Minnesota, Florida, Texas, and Michoacan in southern Mexico. The reviewer is by no means convinced that these new forms are properly placed under *P. illinoensis*. The *Wheeler 92* from Pine Lake, Michigan, seems more like *P. lucens*. At any rate, a plant without floating leaves from Texas and southern Mexico

does not sound very closely related to *P. illinoensis*. Likewise, judging from the very brief description of f. *rosulatus*, one can be very skeptical of its relationship with the local northern species. But to get back to the hybrids, Hagström describes hybrids of *P. illinoensis* with five other species: *P. amplifolius*, *lucens*, *nodosus*, *perfoliatus*, and *gramineus*, as well as one with both *gramineus* and *lucens*. The accompanying map shows the range of *P. illinoensis* and the occurrence of these reputed hybrids, cross-breeds, bastards, or mules as they are called interchangeably.[6] The localities for these hybrids reach from Mystic Pond near Boston, and from New Haven, clear out to Griffin Lake, in the Gold Range Mountains of British Columbia. It should be noted that what is apparently the same plant from Griffin Lake has recently been described as a new species, *P. methyensis* A. Bennett.[7] The Massachusetts locality is 800 miles, and the British Columbian one, 1000 miles in an air line from the nearest known station of *P. illinoensis*. The description of each of these hybrids reads in a convincing manner. The external and internal morphology show intermediate characters, and the plants are for the most part sterile. The other alleged parent grows in the area or near it, but how was the crossing produced to form the hybrid at such a distance? The two stations in Minnesota are within the known range of *P. illinoensis*, so that these plants might conceivably have had such a hybrid origin. The other eleven localities, it will be seen are in entirely different drainage systems. Those in Connecticut and Massachusetts are within a few miles of, and drain into, the North Atlantic. Those in Vermont, New York, Michigan and Ontario drain through the St. Lawrence River. Griffin Lake, British Columbia is in the Gold Range Mountains, and drains into the Pacific Ocean. Even if a specimen is barren, and the stem has its vascular bundles arranged somewhat differently, it has not previously been thought a necessary conclusion that it is a hybrid. In case a botanist determines a plant as a hybrid, on whatever ground, he certainly

[6] The reviewer does not wish even to appear to make fun of Hagström's use of English, which is not always idiomatic or correct. It is always intelligible, and all English speaking botanists will appreciate his writing in it. All new descriptions are in the universal botanical Latin.

[7] Proc. and Trans. Bot. Soc. Edinburgh **29**[1]: 50–51. 1924.

must bear the burden of the proof, showing at least that the alleged parent species are present. In these alleged cases of bastard plants, Hagström has not presented any proof. He does not discuss under any of these particular hybrids the method of

FIG. 1. Distribution of *Potamogeton illinoensis*, forms, and hybrids.

1. Hachured area: range of *Potamogeton illinoensis*.

2. Circle around dots: Florida: locality for forma *rosulatus*. Localities for forma *homophyllus:* Pine Lake, Michigan; Texas; Michoacan in southwestern Mexico.

3. Solid round dots: localities for *P. illinoensis* × *lucens:* Mystic Pond, Massachusetts; New Haven, Connecticut.

4. Circle: localities for *P. illinoensis* × *perfoliatus:* Queenston, Ontario; Griffin Lake, British Columbia.

5. Triangle: localities for *P. amplifolius* × *illinoensis:* Buckingham, Quebec; Cedar Lake, Ontario, Bar Lake, Manistee, Michigan.

6. Dotted area: localities for *P. illinoensis* × *nodosus:* Ferrisburg, Vermont; Little Otter Creek, Vermont.

7. Cross: localities for *P. gramineus* × *illinoensis:* Wenham, Massacusetts; Green Lake, Chisago Co., Minnesota; without locality, Canada.

8. Square: localities for *P. gramineus* × *illinoensis* × *lucens:* Glenwood, Minnesota.

pollination. To this disputed point, he makes no real contribution, merely stating that the species in the subgenus *Coleogeton* are pollinated in the water, while those in *Eupotamogeton* are pollinated by the wind. Graebner says that the species with flowers borne at the surface of the water are wind-pollinated,

while those submersed are pollinated beneath the surface of the water. Fryer suggested at one time that insects might cause the pollination of some of the species, but this has never been demonstrated. Assuming, for the sake of the argument, that all of these six species involved are wind-pollinated, would that make the occurrence of hybrids between them any more probable? The great cyclonic storms that sweep across the continent do have a constant direction from west to east. It might be that the strong wind would pick up pollen grains of *P. illinoensis* one day in the Mississippi valley, and the next day deposit them in Connecticut or Massachusetts. Similar cases have been recorded of pine pollen blown hundreds of miles from the nearest known trees. But, will this explanation work both ways? How is the pollen from *P. illinoensis* in say Minnesota to be blown against the prevailing winds, across the great plains, across the Rocky Mountains, across the Selkirk Mountains, to Griffin Lake in the Gold Range Mountains of British Columbia? To the reviewer this seems preposterous.

Yet this whole case is much like the one shown up by Fernald[8] in his review of Forsaith's paper which describes on the basis of imperfect pollen frequent hybrids between *Epilobium angustifolium* and *E. latifolium*. Fernald points out that in their external morphology these plants show no intermediate characters and that the localities of these reputed hybrids often lack one of the alleged parents. He tabulates many where the nearest known locality for the other parent is hundreds of miles away, or even 1000 miles, as from Surrey, England, to Iceland. Needless to say this casts a very serious shadow over the value of using imperfect pollen as a test of hybridity. To be sure Hagström (pp. 11, 54) admits that *P. Robbinsii* has mostly sterile pollen, and rarely fruits, yet he positively maintains it as a good species; writing,

> It cannot be a hybrid between any modern species. Might not the sterile pollen and the scanty fruiting possibly suggest a survivor from times climatically more favorable to it than the present one? Might we not here have before us a dying species, now-a-days maintaining itself principally in a vegetative way?

In some of our larger genera, for instance *Rubus*, the presence

[8] Fernald, M. L. The assumed hybridization of *Epilobium angustifolium* and *E. latifolium*. Rhodora **20:** 6–10. 1918.

of imperfect pollen is of no value in separating the hybrids from the true species. Brainerd and Peitersen[9] after prolonged study in the field, herbarium, in cultural plots, and by microscopic examination, have separated the blackberries of New England into 12 species and many hybrids. None of the 12 good species have 100 per cent perfect pollen, and the majority of them have anywhere from 60 to 90 per cent imperfect pollen. These cases, with the many others should demonstrate that the production of imperfect pollen, even a very high percentage of it, is no proof that the plant is a hybrid.

An investigation of the literature of genetics will show that the degree of development of a hybrid depends on the nearness of relationship of the parents. A good statement of this varying completeness of growth of hybrid individuals has recently been given by Longley:[10]

> Hybrids may have a short life, never developing beyond a few cells. Others may mature into organisms vigorous vegetatively, but unable to produce flowers and fruit. Others are capable of producing spore mother cells, but these fail to become tetrads. Some can carry out the reduction processes in a characteristic hybrid manner. In crosses between closely related species, pollen-formation shows few signs of irregularities, but the pollen shrivels. Finally there are hybrids between species so closely related that practically no incompatibility exists between the sex cells, and they seem as normal as a typical homozygous species. [p. 313.]

There seems no reason to question the sterile state of these alleged hybrids. Every herbarium is full of sterile specimens. That should cause no surprise to any collector who has hunted for fruiting pondweeds. If he happens to come along at the right time of year, if the water level is not abnormal, if no man or animal has partially destroyed the plants, if he can get a boat or raft or can wade out to the required depth, he may find some *Potamogeton* in fruit, and he considers it a lucky day when he does. Hence the reviewer does not feel that barren or unfertilized Potamogetons must be hybrids.

Hagström does not mention ever having grown any hybrid plants or producing them artificially under controlled conditions. It would take many years and ample facilities to breed these

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[9] Brainerd, E., & Peiterson, A. K. Blackberries of New England—their classification. Vermont Agr. Exp. Sta. Bull. 217. 1920.

[10] Longley, A. E. Cytological studies in the genus *Crataegus*. Am. Jour. Bot. **11**: 295–317. *f. 1–8 + pl. 16–18.* 1924.

perennial aquatics. To the best of the writer's knowledge, the only man to approach this was the English botanist Alfred Fryer. For many years in submersed pots, in tubs, and in shallow ponds, he grew and observed pondweeds. He did not make an intensive study of hybrids, but a number of them were raised and studied. In his beautifully illustrated book, his life work on *Potamogeton*, Fryer writes,[11]

> The hybrids of Potamogetons are not like the hybrids of less variable plants; in some instances they may be constant enough to one type, but in others the variation seems to have no bounds. We find suggestions of not two, but many species, and it is impossible to suppose that these resemblances are accidental or uncontrolled by law. When by observation and actual experiment the law that governs the variation of cross-bred forms of this genus is discovered, wholly or in part, we shall probably get a clearer view of one of the modes by which "species" may have originated.

On the other hand, Hagström writes on page 12,

> The hybrids must be studied according as Nature produces them. Cultivation and experiments in hybridization may not lead to great results as to the solution of this intricate question. A thorough study of the specimens already exactly known as to their origin is much more profitable for the purpose of a correct identifying of others. Rather soon you will learn in which way the one or the other species makes itself prevalent to its compartner, and to recognize the so-called intermediate properties.

On the same page he writes,

> It has been proved that the hybrid *Potamogeton*-forms can abide at the place where they have arisen for long spaces of time, while at last both the parents or either has become extinct and other species have occupied their place. . . . It has happened that in a small river or on a spot very much retrenched four or five different hybrids partly entangled in one another have been met with. For instance in Gudenaa at Kongensbro in Jutland. From there I have, in my own herbarium, *P. gramineus* × *natans*, *crispus* × *praelongus*, *lucens* × *perfoliatus*, *lucens* × *praelongus*, and *lucens* × *nodosus*. *P. nodosus* itself is at present gone out in Jutland.

Such observations and views as these are strongly at variance with those of Fryer, who spent so many years cultivating the *Potamogetons*. Why Hagström argues so strongly against using experimental breeding as the method of solving the hybrid problem is not quite clear. Throughout his monograph he shows in his treatment of hybrids that he interprets them as best he can according to Mendel's Law. If it was by controlled

[11] Fryer, Alfred, Bennett A., and Evans, A. H. Potamogetons of the British Isles 10. 1915.

experiment and recorded observations that Mendel unraveled the hybrid forms of the sweet peas, and if it is upon this well known law that dependence is placed, why does Hagström argue that breeding experiments would be such an unprofitable way to approach the same problem in the pondweeds?

Potamogeton illinoensis has been used as a test. Hagström's use of pollen sterility has not given convincing results. His recognition of intermediate characters in the appearance of the supposed hybrid has not served as a trustworthy check. The ranges of the two supposed parents, although clearly stated, do not seem to influence his opinion. He is the first to make extensive use of stem anatomy in identifying the species and hybrids of *Potamogeton*. The reviewer has no preconceived notions of its value. Still, Hagström places more emphasis on stem anatomy than on any other character of the plant. Judging by the dubious taxonomy derived, this new method seems of but doubtful help. It should not be inferred that the reviewer has been blind to a great deal of good material in this monograph, but it is thoroughly intermingled with the questionable. Through complete lack of any key, no short cuts are possible, and only a specialist familiar with the genus can winnow out the good from the bad.

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The author of the foregoing paper has invited the editor to add a biographical note on this Swedish contributor to American botany.

Johan Oskar Hagström, born 21 March 1860, at Bettna, Strängnäs, Södermanland, died 7 June 1922, at Västra Emtervik, Värmland, Sweden. He became a student in Upsala University in 1879, took his examinations for holy orders in 1883, became curate in Lysvik in 1899, was appointed rector in Västra Emtervik in 1910, and rural dean in 1917. That a busy churchman should find time to become so well recognized as a specialist in *Potamogeton* that he was called upon to elaborate this genus for Neuman's Sveriges Flora (1901) and for Lindman's Svensk Fanerogamenflora (1918) is a matter of interest. In conversations with botanists in Sweden during the past summer, I gathered that Hagström's work in general was well regarded by them. A list of his papers, chiefly on *Potamogeton* and *Ruppia*, may be found in a brief account in Botaniska Notiser 1922: 223, from which this notice is mainly compiled.—T. E. H.

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